Models of History

How is digital technology helping scholars interested in cultural history understand the past? And will you one day 'visit' long-lost places?

By Scott Hauser

How do you bring the past to life?

For historians and other scholars who analyze cultural, architectural, and physical history, the answer may be as close as the latest software update.

Faculty at Rochester are turning to increasingly available imaging, 3-D visualization, and immersive world technology to imagine virtual spaces—projects designed to use the facts and details of history to inform new ways of understanding and analyzing the past.

The projects range from an exploration of ancient Roman monuments to a 400-year history of Bermuda, as Rochester scholars turn to technology—and to one another—to think of new ways to share their scholarship.

"The opportunities for interdisciplinary collaborations in this field are phenomenal," says Renato Perucchio, a professor of mechanical engineering and director of the College's Program in Archaeology, Technology, and Historical Structures who has been using computer technology to analyze ancient structures over the last 10 years. "By their very nature, these are multidisciplinary projects."

And while the final piece of scholarship may live online, the academic work undergirding them does not change, says Joan Saab, an associate professor of art and art history who is helping to lead a project to build a 3-D model of an architecturally significant train station in Rochester that was torn down in the 1960s.

"For me, this is a chance to do the work and model a type of rigorous, scholarly practice," she says. "We want it to have the scholarly rigor that an article or a book would have."

Such technologically rich projects are designed to provide visual, interactive ways to better engage and inform students, other scholars, and the public. They also allow researchers to simulate experiences and conduct experiments that would not otherwise be possible, and may offer insights into ways to preserve ancient objects and structures.

Michael Jarvis, associate professor of history who has been working to create a virtual version of Bermuda, says the technology has opened new doors to re-imagine the past.

"The act of reconstructing—either restoring modern places to

ISLAND VIEWS: Using software that captures and collates geographic and spatial data, Jarvis and his team are recreating a multi-layer map of Bermuda (inset, above) while students are using common 3-D visualization software to model historically correct houses and other buildings (inset, below), based on property records and other information.

AODH DUBH/CC BY 2.0 (MAP OF BERMUDA); COURTESY OF MICHAEL JARVIS (MODELS)

historical appearances or reconstructing lost buildings—forces you to think in a level of detail that you normally wouldn't," he says. "We know what happened but we don't 'get it' in the way that visualization brings to bear."

Here are a few examples of projects currently under way.

Virtual St. George's

Imagine yourself on the shore of 17th-century Bermuda. Your ship has anchored just beyond the reef, and from the railing you can see a few small, timber houses that make up the settlement of St. George's. Beyond those few buildings, the 20 square miles of the island are dense with lush, green wilderness. Beyond that is 600 miles of open Atlantic ocean and the New World with its lonely outpost of struggling Jamestown, Virginia.

Fast forward to 2014 and St. George's is a vacation island destination. While the footprints of those first few buildings remain, the history of Bermuda has gone on unabated as generations of settlers, sailors, shipbuilders, and slaves made their homes on the tiny archipelago.

What if you could "see" that history as it unfolded? Better yet, what if you could put yourself on the streets of the original capital of St. George's, interacting with fellow Bermudians in day-to-day life and commerce?

While Michael Jarvis, associate professor of history, can't travel with students back in time, he's envisioning the next best thing to a time machine. Using digital technology, he's working on a virtual version of Bermuda that will allow students and others to explore, experience, and understand the 400-year history of the longest permanently inhabited settlement in English America.

"I want to let people stand there and walk the streets and look at the buildings as they stood in 1620, in 1680, in 1750, and probably 1775 at the start of the American Revolution," says Jarvis, who has been studying the history of Bermuda for more than a quarter century.

As part of his research, he has collected nearly four centuries of detailed data, a trove of information captured in deeds, wills, baptismal records, tax rolls, and the other facts that power the bureaucratic life of every society. Jarvis can follow the ownership of a particular piece of property over lifetimes, much like a storyteller following a multigenerational epic.

By matching that information with building records and analyzing it with imaging, mapping, and 3-D visualization software, Jarvis is slowly recreating a Bermuda that has disappeared from view. He envisions taking that recreated island one step further, using some of the common software behind video games to make an immersive world where Bermudian society comes to life.

Claude Bragdon

"We can put historically accurate people in historically accurate contexts," Jarvis says. "For example, almost like in a video game, you could walk up to a house in a particular year and knock on the door and Widow Tucker will answer the door. We know that Widow Tucker was 45 years old and she had three children and five slaves. We can restore everybody in the town to their houses in a particular target year."

To create the original prototypes for the project, Jarvis has led undergraduates and graduate students in a project to integrate historical data into databases, conduct independent research on specific buildings and property owners using digital newspaper archives, and "build" individual houses using software such as Google's SketchUp, a free rendering software used to model 3-D objects, and more advanced computer-aided design software. Using archaeological records, property rolls, and other information, the students can not only recreate the buildings, but they can also "furnish" them with objects that property owners listed in deeds and wills.

Jarvis says that by doing such work, he and the students are able to understand Bermudian society at a level that isn't possible by simply poring over records. When you see the layout of a house, for example, and you know who lived there and how they lived, you start to ask new questions, he says.

"You know that there were eight slaves in the house. Where did they live? How did people interact on a daily basis? Where would white and black members of the household have slept each night?" he says. "What was the social space inside the physical space? The act of visually reconstructing these spaces raises these new questions."

And as he brings more interactivity to his virtual version of Bermudian society, he expects those questions to become more compelling.

"There's a level of historical accuracy that's possible now with the new technology," he says. "Everybody who lived there—be they adult, children; black, white; slave, free—everybody is equally worthy of study, and by putting this together, I can see how 17th-century life was different from 18th-century life and how 18th-century life was different from 19th-century life in a very real way."

Rochester's Third New York Central Train Station

During its heyday in the first half of the 20th century, many thousands of travelers, soldiers, college students, and commuters passed through the landmark Third New York Central Train Station in downtown Rochester.

Few of them probably were aware that the monumental building—with its cathedral-like waiting room, geometrically patterned tiles, and other seemingly decorative embellishments—was meant to embody many of the artistic, architectural, philosophic, and spiritual ideas of its designer, Claude Bragdon. A figure straddling the 19th century's ideas about urban architecture and the 20th century's emerging modernism, Bragdon thought of the station as an "architectural performance." He hoped it would be a space where his notions of transcendence and the possibilities of higher orders of human experience could be on display, say Joan Saab, associate professor of art and art history, and Joan Rubin, the Dexter Perkins Professor in History.

When the building was torn down in the 1960s, scholars of cultural history lost not only the physical structure, but also the experience of what it was like to stand in the space itself. What if they could virtually capture the feeling of being in the building? Would that open a window on Bragdon, his artistic ideas about public spaces, and his influence on the cultural arts of the early 20th century?

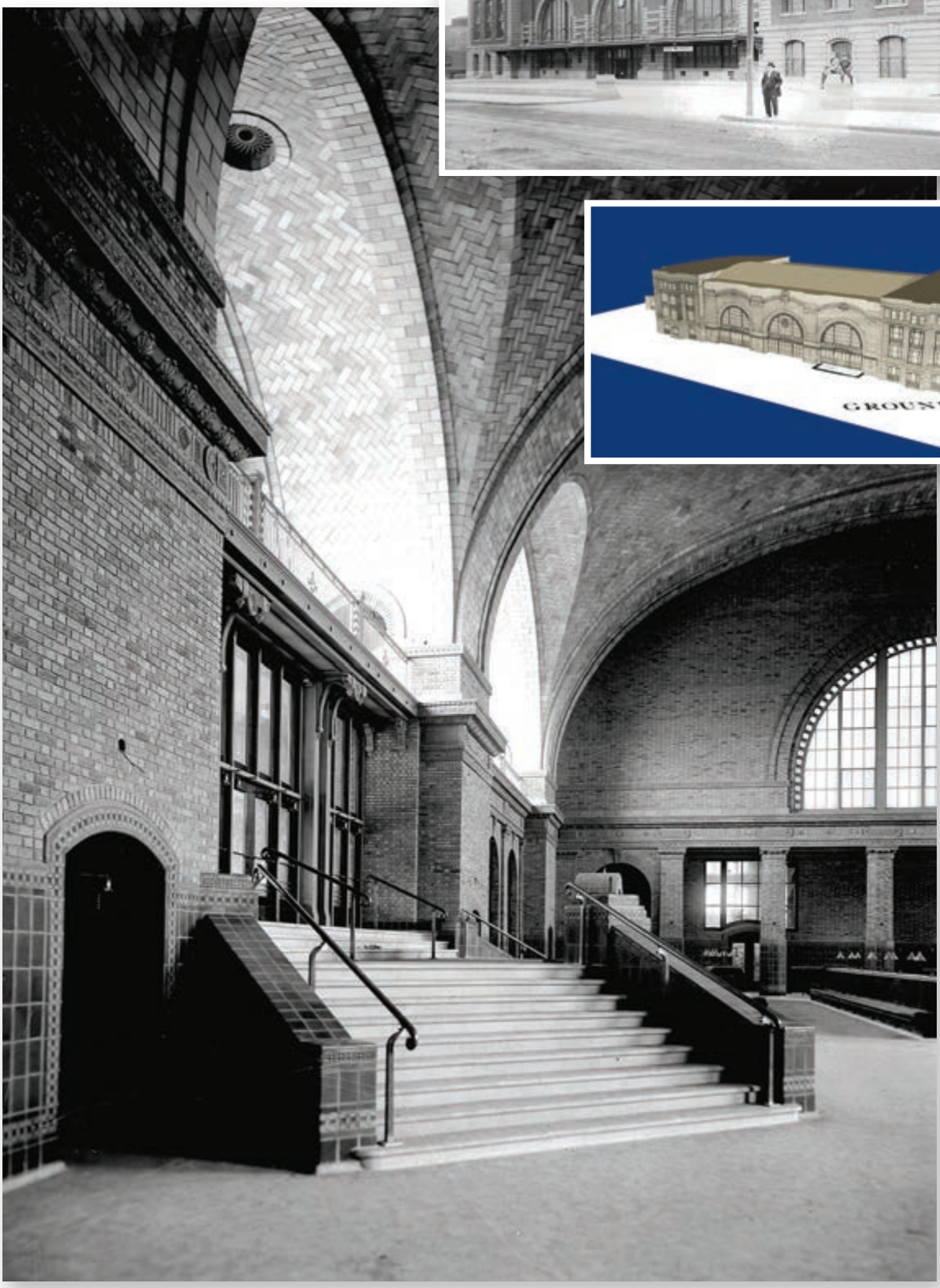
Working with archivists and technologists at Rush Rhees Library, home to the leading collection of Bragdon's papers and other materials, the two are leading an effort to bring the station back to life as a virtual, 3-D model.

"For me, this really came out of a teaching dilemma," says Saab. "When you teach architectural history, particularly buildings that no longer exist, it's difficult to get a sense of what the spaces were like. And with Bragdon, there's that extra richness because he had so many ideas about architecture that you can't get from black-and-white photographs. But once you can colorize the tiles and put them in a space, you can say, 'Oh, I get what he's talking about.' Whether or not it works is up to the person viewing the space. But that's one of the things we're trying to do. It's moving Bragdon from 2-D to 3-D."

Among the materials housed in Rush Rhees are blueprints, working designs, and correspondence about the train station, as well as

FROM THE COLLECTION OF THE ROCHESTER PUBLIC LIBRARY LOCAL HISTORY DIVISION

HISTORIC STATION: Drawing on blueprints, papers, and artifacts housed in Rush Rhees Library, Rubin and Saab are leading a project to create a 3-D model of an iconic former Rochester train station, considered one of designer Claude Bragdon's architectural masterworks. The result would be a multi-layered historical analysis of Bragdon's ideas about art, architecture, and public space.



Station Memories?

As part of the project to create a virtual version of the Bragdon train station, the research group is interested in hearing from people who visited the building while it was still in use. Contact the team at Bragdon.UR@gmail.com.

FROM THE ALBERT R. STONE NEGATIVE COLLECTION, ROCHESTER MUSEUM & SCIENCE CENTER, ROCHESTER, N.Y. (EXTERIOR AND INTERIOR); COURTESY OF JOAN SAAB (MODEL)

artifacts from the building that were salvaged when the building was razed. The project aims to recreate an architecturally accurate version of the station—down to the detail of light fixtures, water fountains, and tiles—that viewers will eventually be able to interact with almost as they would an electronic game.

As technologically impressive as they hope the project will be, the two are making sure not only that the details are historically accurate, but that they also are put in their proper historical and cultural context, an approach that Rubin calls layering.

"Image if you could 'go' into the building, and you click on a cornice. You can learn what a cornice is; you can also see Bragdon's comment about the cornice, or his letter to his sister about the cornice. There will be layers of information and context and analysis."

While the project is using the train station as a focal point, the goal is to get a broader understanding of Bragdon and his place in American cultural history.

"It's really Bragdon through the train station," say Saab. "You could do this for any building, but Bragdon is an interesting enough character that he can carry a project on his own.

"He wrote quite a bit about his ideas—of the spiritual properties of the space and architecture as 'frozen music' and the relationship between colors and material and between form and bodies—that's compelling to me as somebody who studies and teaches architectural history."

The designer behind several prominent buildings in Rochester, Bragdon eventually had a falling out with George Eastman, and he left for New York, where he became a nationally recognized designer for theater and stage productions, as well as for producing "Song and Light" festivals in Central Park, an idea that he first tried out in Rochester's Highland Park.

"As a cultural historian, I'm interested in the relationship between Bragdon's spiritual ideas and modernism, which is the style that we see emerging in the period right when Bragdon is working," says Rubin. "I'm interested in how to place him culturally. He had a cult following, and he was nationally known, but one of the things that intrigues me is that he is himself multifaceted."

Eternal Rome

If anyone has come across the civil engineering code for Imperial Rome, circa 200 CE, Renato Perucchio would like to borrow it.

Barring the likelihood that such a historic codex will emerge any time soon from a long-lost archive, the professor of mechanical engineering is using technology to recreate and understand the evolution of engineering in ancient Rome.

Since 2005, he has led a team that's analyzing a series of monuments built in Imperial Rome from the eras of Trajan to Constantine. Using 3-D solid modeling and engineering structural analysis software, he's analyzing a series of well-preserved concrete vaulted buildings, including some of the largest structures built in antiquity. The goal, Perucchio says, is to understand the evolution of structural thinking and the technological evolution of ancient engineers.

"Civil engineering embodies the technology of the time and at the same time, the willingness of builders to take risks," says Perucchio. "Clearly we don't have the civil engineering code of Imperial Rome, but the complexity of these monuments make it such that you cannot build them based on an oral tradition."

By analyzing how the structures were built and comparing earlier buildings to later monuments, Perucchio and his team can see how techniques evolved to help make sure the buildings could withstand damage.

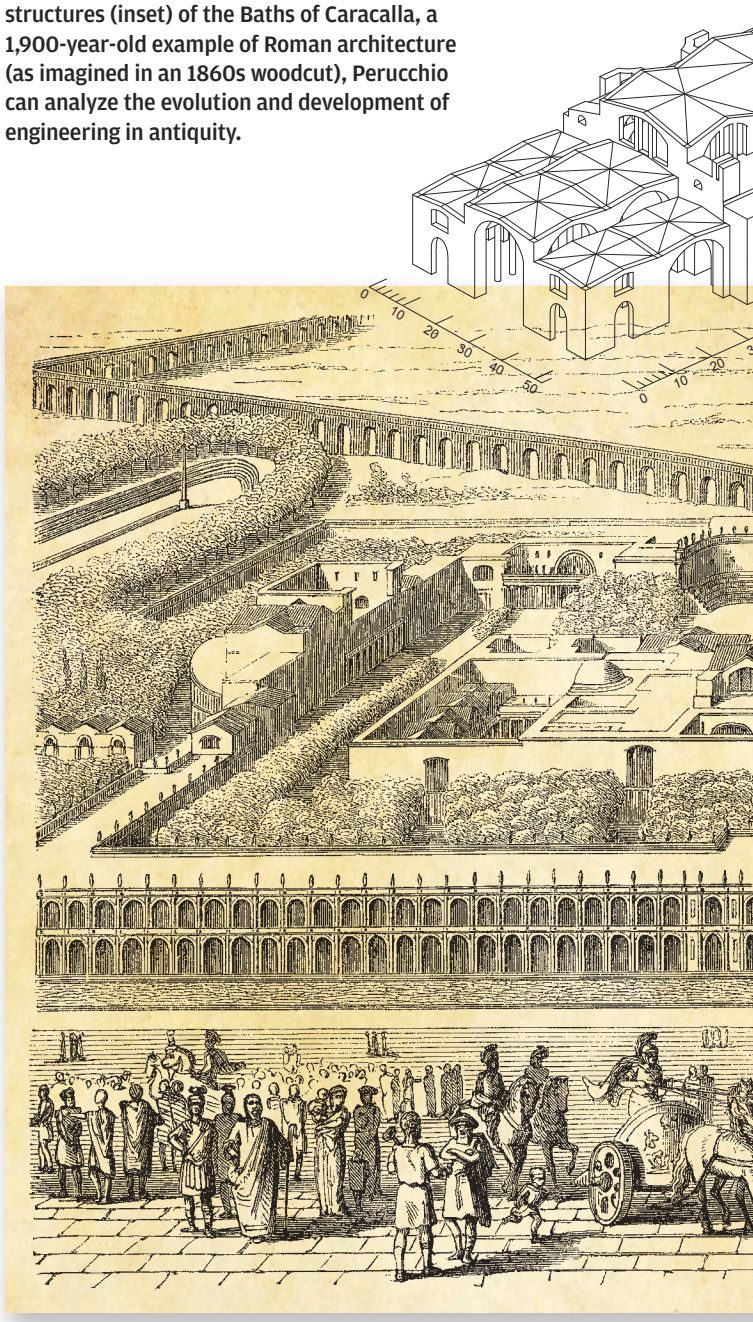
"As an engineer you can study the factors that produced problems—often critical—in a building," Perucchio says. "And then if you look at other buildings, you discover that specific items have been changed. What you infer is that, 'Well, these people looked at what was going on, understood the mechanism of a possible collapse, and modified their design so that the collapse was avoided in subsequent structures.'

"It's very much what we do today. Engineering proceeds this way—either doing it numerically or experimentally or combining the two."

And today that analysis relies on massive computing power and sophisticated imaging, rendering, and 3-D simulation software. Using a technique called nonlinear finite element modeling, Perucchio and his students can not only model the structures, but they can also analyze damage to unreinforced concrete structures, the kind that might occur, for example, during an earthquake.

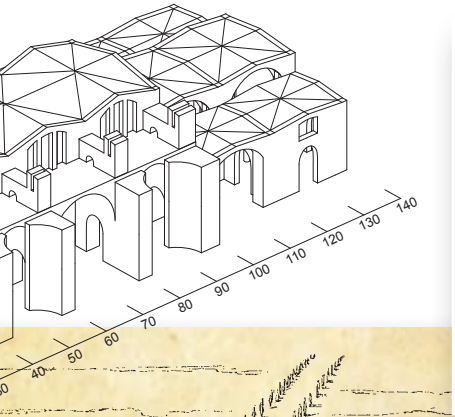
In order to do that, though, Perucchio's team faces an added challenge. Modern engineering analysis tools are designed to analyze modern buildings built with steel, reinforced concrete, and other materials. The Roman engineers working in imperial times had none of those available.

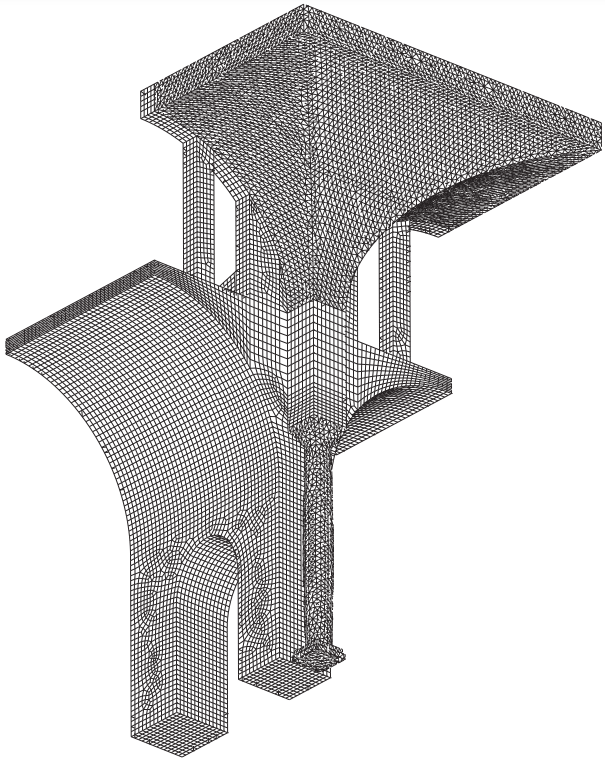
"Paradoxically, materials that were used extensively in antiquity



VAULTS OF ANTIQUITY: By modeling the vaulted structures (inset) of the Baths of Caracalla, a 1,900-year-old example of Roman architecture (as imagined in an 1860s woodcut), Perucchio can analyze the evolution and development of engineering in antiquity.

ISTOCKPHOTO (WOODCUT)





DETAIL VIEW: A detail of a finite element model created by Perucchio and his team shows the vaulted structure of the *frigidarium*, an area of the Baths of Caracalla with the highest vaulted structure.

are very, very difficult to model with modern tools," he says. "In order to understand the engineering of ancient peoples, we need to develop very sophisticated approaches that are much more complicated than modeling steel or modeling reinforced concrete."

Working with small blocks from the monuments, the team adjusted their analytical tools to understand how ancient concrete reacted to the stressing and crushing and bending that every structure faces in its lifetime.

"The best way to think of these structures is that these are live entities that adjust themselves over time," he says. "And in order to understand how they do that you need to have the physical properties of the material. That requires some very sophisticated experiments."

In recent years, Perucchio begun analyzing other ancient structures, such as an enormous adobe pyramid in modern-day Peru that was built by the Moche people of South America, a civilization that thrived from 100 CE to about 800 CE. The work is conducted jointly with a multidisciplinary team including colleagues from Rochester and the Pontificia Universidad Católica del Perú in Lima.

"The approaches that we have developed are really very powerful and can be applied to a fairly large number of structures," Perucchio says. "The common feature is that these types of structures usually cannot be analyzed with modern tools. You have to develop your own data as well as your engineering analysis tools."

And while Perucchio says his projects typically don't address how ancient structures can be preserved or protected, the research can help guide such efforts by understanding how the structures were designed and where they are most vulnerable.

"For me, it's a simple point: you learn through mistakes. That something was going to stand up, but instead it fails. These were very sophisticated people, and they understood that. They were able to conduct a critical analysis of their errors and develop new structural solutions. This is pretty much what engineers do even today."

ISTOCKPHOTO (BATHS OF CARACALLA); COURTESY OF RENATO PERUCCHIO (MODELS)