

The formulae $\frac{\partial \rho U_i}{\partial x} + \frac{\partial}{\partial x_j} (\rho v_j U_i) - \frac{\partial \rho}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} \right) + g_i (\rho - \rho_0)$ for building $\frac{\partial}{\partial x_j} (\rho U_j H) - \frac{\partial \rho}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} - \rho v_i U_j \right) + g_i (\rho - \rho_0)$ state of the art $\frac{\partial}{\partial x_i} (\rho U_i H) - \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} - \rho v_i U_j \right)$ biomedical research facilities.

Architectural Mock-Ups

Laboratory buildings are often as innovative and complex as the research that they contain, so the use of mock-ups during the design and construction phases is crucial to their success. Mock-ups, ranging from room-sized to small details, allow for critical components to be tested, assessed and approved early in the process. Once constructed, mock-ups can be modified to meet performance and aesthetic requirements, and to address comments and concerns of stakeholders. Upon approval, mock-ups can be maintained for the duration of the project and used as a standard for quality, and as a basis for acceptable work.

The number and types of mock-ups should be determined based on the complexity and criticality of the project. Mock-ups may not be necessary for established construction methods and materials, but are required for assemblies that are innovative or untried, are dependent on installer skill and technique, or are essential for the success of a critical facility.

There are many types of mock-ups including:

Component mock-ups

Component mock-ups are actual building materials and components, installed as intended in the final construction. The goal of component mockups is to have an actual, full-size sample of the finished product or assembly which can be viewed by stakeholders, approved for quality, compatibility, appearance and other performance and aesthetic criteria. Mock-ups may be tested (e.g. infiltration for envelope assemblies, chemicals for laboratory surfaces, adhesion for floors) or otherwise analyzed to confirm that performance criteria and expectations are met.

- **Construction assembly mock-ups:** Assemblies built with the materials and methods intended for the final building construction. They are typically required where components are constructed in an untested or unique way. Construction assembly mock-ups should be as complete as possible, and include anchorages, adjacent assemblies, corners, terminations, sealants, transitions, joints, penetrations and other critical construction details. Construction assembly mock-ups may include sections of interior or exterior walls, roofs, casework, doors, windows or any other building component. Construction assembly mock-ups can be constructed on-site as freestanding assemblies or as part of the permanent construction.
- **Detail mock-ups:** Crucial installation, joint, connection and transition details that are dependent on workmanship, compatibility or field conditions.
- **Finish mock-ups:** Assemblies of room finishes, required to view and approve the aesthetics, transitions, installation workmanship and other details of all components. Mock-ups should include all materials and

conditions, and typically include floor finish, base, wall finish, cabinetry, and ceilings. Finish mock-ups may be a portion of a room or an entire room, and may include furniture, equipment, lighting and other key room components.

Volumetric mock-ups

Volumetric mock-ups are developed to allow the flow of people, materials, functions and environmental experiences of a space to be tested before it is physically built. These visualizations allow for the optimization of the characteristics being modeled and to convey the look and feel to stakeholders who may not fully understand what the traditional lines on paper will mean experientially, after construction.

- **Physical mock-ups:** Temporary mock-ups built from cardboard or other inexpensive material to simulate the volumes and geometry of a room. They are built to full size, and allow users to physically test reaching length, sightlines, ergonomics, placement of major components and other important geometric aspects of a space. Volumetric mock-ups can be useful when designing laboratories, control rooms, patient rooms and other spaces where efficiency of movement, comfort and clearances are important.
- **Virtual mock-ups:** 3-dimensional digital representations which give stakeholders a sense of the size, characteristics and function of a space. Virtual mock-ups can be static images, pre-programmed, or user-controlled dynamic walk-throughs. Virtual reality technology is becoming available that will allow for a more enveloped simulated experience of a space. Virtual mock-ups are useful as representational tools, but do not allow the space to be physically experienced.

Specifications

The identification of mock-ups needed for a project should be discussed with the Project Officer and stakeholders early in the design process. The requirements for mock-ups should be in the specification section for individual products, or in Division 1 Quality Requirements (MASTERSPEC Section 014000) for assemblies composed of multiple products. Specifications should clearly state the composition, size and scope of the mock-up, the location (on site or off-site), testing and whether the mock-up can be incorporated into the final construction. The architectural drawings should indicate the size and extent of large assembly mock-ups.

Conclusion

Mock-ups are invaluable tools for allowing innovative and crucial details and assemblies to be assessed, and to act as a standard by which work will be accepted.

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