

The formulae $\frac{\partial \rho U_i}{\partial t} + \frac{\partial}{\partial x_j} (\rho U_j U_i) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial U_i}{\partial x_j} \right) + g_i (\rho - \rho_s)$ for building $\frac{\partial}{\partial x_j} (\rho U_j \bar{H}) = -\frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j} \left(\mu \frac{\partial \bar{H}}{\partial x_j} - \rho \bar{u}_i \bar{u}_j \right) + g_i (\rho - \rho_s)$ state of the art $\frac{\partial}{\partial x_j} (\rho U_j \bar{H}) = \frac{\partial}{\partial x_i} \left(\lambda \frac{\partial \bar{H}}{\partial x_i} - \rho \bar{u}_i \bar{H} \right)$ biomedical research facilities.

Pre-Design & Evolution of Design Part II

Pre-Design:

Last month's Part I emphasized the importance of pre-design efforts, particularly collecting data through Q&A sessions with the user prior to beginning the design process. The article stressed the significance of asking the right questions and **understanding** the reasoning behind the answers; the key is replacing the 'what do you want' questions with 'what do you do' and 'how do you do it.' This sort of in-depth analysis may be done through Questionnaires; the information collected during these Q&A sessions is used to generate the form-producing parameters used in the next phase of design: bubble diagrams.

Bubble Diagrams:

A bubble diagram is the first attempt at a graphic representation of the collected data, in the form of "bubbles" and lines. The "bubbles" depict the functions of the space, which are arranged in proximity to one another based on desired adjacencies and/or separation, line of sight, etc. Lines are drawn to connect the bubbles that portray the relationships between the functions. Bubble diagrams are used to establish spatial relationships between the functions and spaces and help determine the best layout for a particular program. Although this drawing may not ever make it into a formal submission, this is a critical step in the design process.

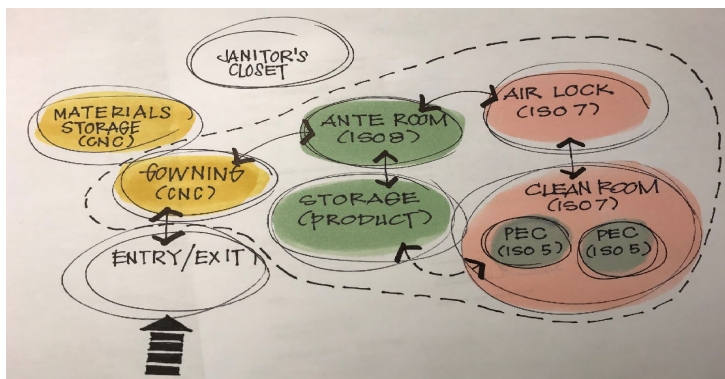


Figure 1: Bubble diagram

Further development of the bubble diagram places forms or rooms around the bubbles and functions to form the basis of schematic designs.

At the end of the pre-design phase, the following activities will have either commenced or been completed:

- Establish project program and parameters
- Establish Integrated Project Team

- Data gathering (Questionnaire)
- Establish codes, regulations, standards, guidelines, etc. applicable to the project
- Initiate Room Data Sheets
- Equipment Schedule
- Perform site and engineering surveys
- Conducted Preliminary Engineering analysis
- Conducted Preliminary Risk Assessment (RA) (as required)
- Perform Feasibility Studies (as required)
- Bubble diagrams

The information collected during the pre-design stage is captured in the Basis of Design (BOD), along with all major design criteria. The BOD is used as the Project Team's record of discussions, decisions, rationale, etc. made along the way, and serves as a reference document for all disciplines that is continually updated as the design progresses.

Schematic Design (SD):

In this phase, the designer introduces shape, size, location, and inter-relationships to the design concept from the bubble diagrams, and forms begin to take on three dimensions. Designers must integrate organizational, operational, and infrastructure challenges with innovative, thoughtful design to create spaces that are functional as well as inspirational for their clients. They must also explore alternative layouts to select the best solution for continued development.

Schematic design benefits from a high level of interaction between designers, clients, stakeholders, etc. Consider holding design charrettes involving all stakeholders, as this contributes to a collaborative, integrated planning process that leverages the collective knowledge and input of users, stakeholders, and Subject Matter Experts (SMEs) in conjunction with the creativity and technical building expertise of designers and participants. Also consider using computer modeling along with virtual reality or 3D sessions to help users understand the design layout and spatial concept in a 3D format.

At the end of the schematic design phase, all project criteria and parameters should be set and documented. The project shall proceed to Design Development and Construction Documents upon review and acceptance by all stakeholders.

Design Development (DD) /Construction Documents (CD):

As the design progresses, additional details and documents are added and the design is further refined, culminating in a series of documents (drawings, specifications, calculations, etc.) that are collectively referred to as Construction Documents (CD) and used in the follow-on phases, bidding and construction. These topics will be discussed in next month's follow-up article.

'Design Requirements Manual (DRM) News to Use' is a monthly ORF publication featuring salient technical information that should be applied to the design of NIH biomedical research laboratories and animal facilities. NIH Project Officers, A/E's and other consultants to the NIH, who develop intramural, extramural and American Recovery and Reinvestment Act (ARRA) projects will benefit from 'News to Use'. **Please address questions or comments to:** shawm@nih.gov

Further details on this month's topic are available on the DRM website Chapters 2

<https://www.orf.od.nih.gov/TechnicalResources/Pages/DesignRequirementsManual2016.aspx>