QUALITY MODELING: DEFINING PROJECT EXPECTATIONS

Dr. Stephen J. Kirk, AIA, CVS
Vice President and Director of Facility Economics
Smith, Hinchman & Grylls Associates,Inc.
Detroit, Michigan

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Theodore C. Fowler, CVS, Fellow, SAVE

Dr. Stephen J. Kirk, AIA, CVS is Vice President and corporate director of facility economics for the architectural/engineering firm of Smith, Hinchman & Grylls Associates, Inc., Detroit, Michigan. He is responsible for SH&G's overall value and cost management program where he integrated VE into the corporate design process. Dr. Kirk has personally led over 200 VE studies of hospitals, research facilities, offices, manufacturing facilities, military projects, and environmental and transportation projects. He was a Senior Fulbright Scholar in architecture in 1982. Dr. Kirk is the author of 6 books related to VE and routinely gives seminars both nationally and internationally. He is a registered architect and received his Doctorate of Architecture in VE gaming/simulation from the University of Michigan.

ABSTRACT

This paper describes a new VE technique for the construction industry called "Quality Modeling." This Total Quality Management (TQM)-based approach can be applied during the planning and design stages of a project. It assists in the defining, measuring and managing of owner quality expectations. Key components of effective quality modeling and conformance measurement are discussed. These tools serve as a successful management approach for improved project decision-making. This technique utilizes a computer simulation model called, VeNTURE in VE workshops. Sample case study examples from health care, industrial, research and office facilities are included.

INTRODUCTION

Modeling, measuring and managing quality are critical to meeting owner expectations regarding the planning, design, and construction of their facilities. The approach presented is based on TQM (total quality management) and consists of three parts:

1. Modeling Quality Expectations
2. Measuring Quality Conformance
3. Managing Project Quality

Our experience has shown that this approach is equally applicable to all types of facilities including financial, health care, industrial, research and development and corporate office facilities.

MODELING QUALITY EXPECTATIONS

The quality model is the entry point during the planning phase for establishing and developing the owner's project criteria. In an interactive workshop setting, project expectations are brought out, explored and documented. These expectations may involve schedule, image, flexibility, functionality, technical systems performance, budget adherence or any other issue which may shape the direction of the project. The relative importance between these competing values are explored, prioritized and documented with the owner.

The quality model provides a thorough definition of project performance expectations required by the owner. SH&G has found that most project expectations can be organized into twelve competing value elements as listed and defined on Figure 1.

QUALITY MODEL ELEMENTS

OPERATIONS

Operational Effectiveness	The degree to which the building is able to respond to the work process and flow of people, equipment, and materials.
Flexibility/Expandability	The degree to which the building plan can be rearranged to conform to revised work processes and personnel changes. The ability of the building to grow to meet projected changes in the work process without disturbing existing building functions.
User Comfort	How the building provides a physically and psychologically comfortable place for people to work and live.

RESOURCES

Capital Cost Effectiveness	The economic consequences of the building in terms of initial capital investment including construction cost, design fees, land costs, etc.

Operations & Maintenance	The degree to which the building is able to conserve energy resources through construction, site orientation, and solar design. Other considerations include maintenance, operations, and replacement costs.
Schedule	The amount of time required to complete the various tasks including programming, design, construction and start-up/move-in.

TECHNOLOGY

Environmental	The degree to which the facility is sensitive to environmental concerns such as hazardous waste, air & water pollution, use of sustainable materials, recycling, etc.
Security/Safety	The degree to which the building can segregate sensitive functions from one another and prevent the entry of people to restricted areas.
Engineering Performance	How the building operates in terms of mechanical systems, electrical systems, and industrial processes.

IMAGE

Site Planning/Image	The degree to which the site responds to the needs of the project in terms of parking, vehicular & pedestrian traffic, outdoor amenities, and the visual impact to employees and visitors.
Architectural Image	The visual concept of the building and the way in which the building attracts attention to itself. The form of the building and the degree to which it acts as a symbol for the company.
Community Values	How the building and its site project a "good neighbor" identity in terms of safety, security, and privacy.

FIGURE 1

Through collaborative workshops with the owner, a clear understanding, documentation and prioritization of the above competing values are realized for the project. These expectations and goals are explored and discussed in the workshop. Specific owner definitions of each competing value are developed. The quality model consists of narrative descriptions of each value and a graphic diagram which shows the relative priorities between the 12 major competing values.

For each element of the quality model, up to six component measurement scales are developed. These components vary depending on the project type. For example, the components of "operational effectiveness" for a health care facility might include:

- Average Length of Stay
- Staff Cross-Training Efficiency
- Appropriate Functional Adjacencies
- Just-In-Time Supplies Delivery
- Staffing Ratio / Patient / Treatment / Visit
- "Right Sizing" (SF / Functional Area)

For an industrial facility, the operational effectiveness components might include:

- Production Rate
- Maximized Utilization of Equipment
- Minimized Process Travel Distances
- Just-In-Time Supplies Delivery
- Staff Hours / Unit of Production
- Square Feet / Unit of Production

Figure 2 illustrates the quality measurement scale for the component "air quality" of the "engineering performance" element. These measurement scales are later used to evaluate alternatives as the project begins to move into the design phase.

The participants in the quality model workshop normally represent five points of view so that when a consensus decision is reached, all areas of interest have been addressed. These five types of participants include:

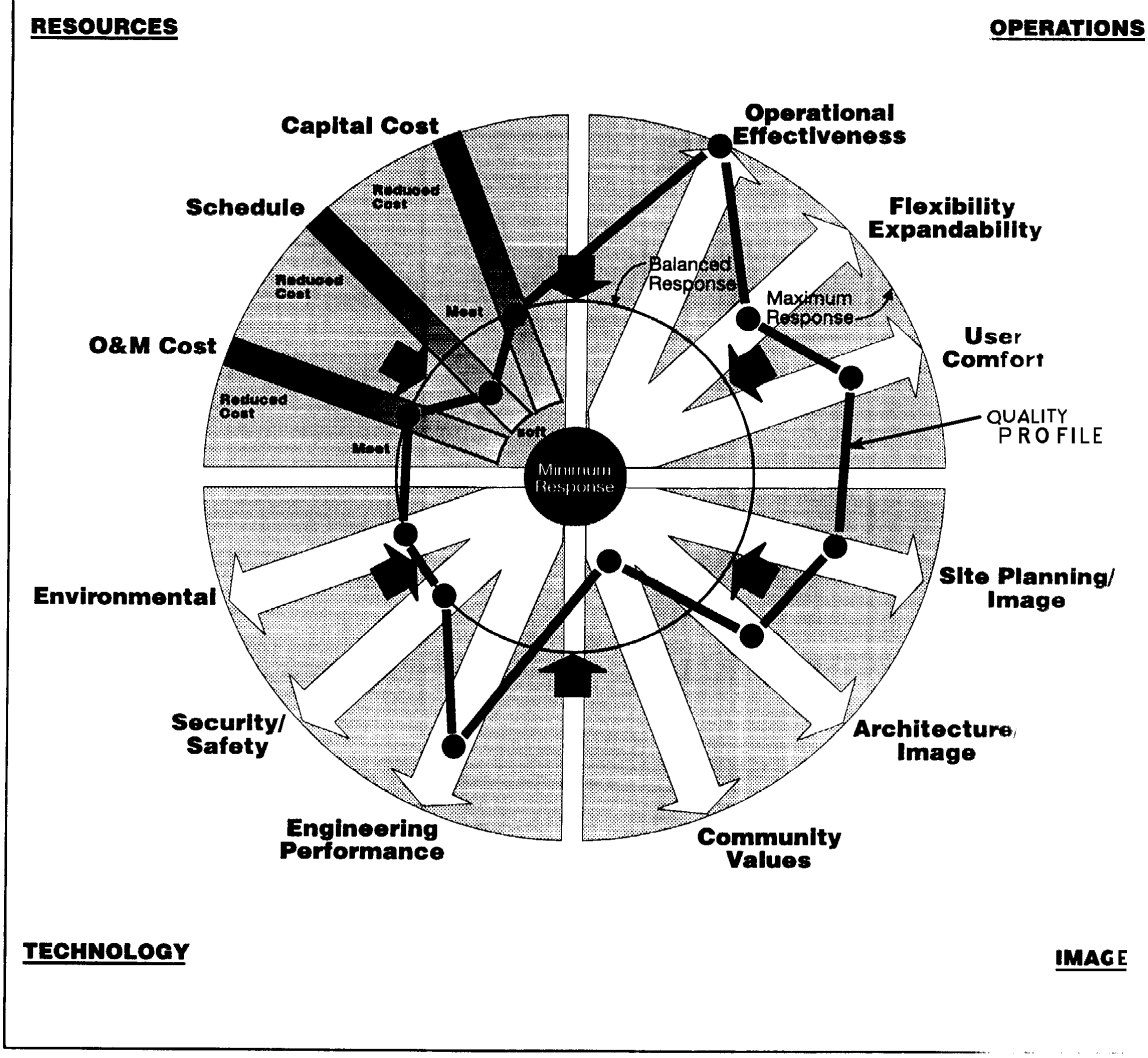
Owner (Financial)
User (Functional Use)
Designer (Architects / Engineers)
Builder / Constructor
Facility Manager (Operations & Maintenance)

This collaborative workshop environment involving the client and the A / E team helps to build a clear mutual understanding of: objectives, how the facility should perform, what issues are the most important, and most of all, what the client ultimately requires; both tangibly and intangibly.

EXAMPLE QUALITY MODEL: NEW UNIVERSITY SCIENCE BUILDING

Figure 3 illustrates a quality model diagram for a new university science building. It represents the relative weighting of importance among the 12 quality elements. A low response indicates an element is less important with respect to other elements. The weighting for each element was determined by consensus among those faculty members in attendance at the workshop at the campus. Below is an interpretation of the results shown on the quality model diagram.

Quality Model New University Science Building Figure-3 SH&



OPERATIONS

- **Operational Effectiveness**

  Maximum response; the operational objective of improving the quality of the laboratory and teaching space is critical to the success of this project.

- **Flexibility / Expandability**

  Moderately high response; the ability of the facility to accommodate changing activities is required for the long-term viability of the facility. The building design should not preclude expansion.

- **User Comfort**

  Moderately high response; comfortable accommodations for both faculty and students are necessary to achieve teaching and research effectiveness.

RESOURCES

- **Capital Cost Effectiveness**

  Balanced response; the total project budget is fixed at $11.75 million, with no additional funding expected. The funding is modest to meet the quality and program expectations as currently defined.

- **Operations & Maintenance Cost Effectiveness**

  Balanced response; efforts to minimize costs consistent with the capital budget are important to the on-going effectiveness of the facility.

- **Schedule**

  Moderately low response; design to occupancy is July 1993 - May 1996. No factors exist which would require acceleration of the delivery schedule.

Specialized equipment lead times fit into the projected schedule.

TECHNOLOGY

- **Environmental**

  Balanced response; the construction should minimize adverse impacts on the site and on the environment in general. Of particular concern is the indoor air quality, recycling of waste and storaging and removal of hazardous waste.

- **Security / Safety**

  Balanced response; adequate security measures are required to ensure the safety of faculty and students and adequate protection of the laboratory equipment.

- **Engineering Performance**

  Moderately high response; The new science building is technically complex with high demands on building systems, thus the engineering design is critical to proper functioning of laboratory systems and equipment.

IMAGE

- **Site Planning / Image**

  Balanced response; the site planning should maintain the architectural character of the campus. Site drainage and utilities are a major design consideration.

- **Architecture / Image**

  Moderately high response; the facility should reflect the importance of science education at the college and maintain the architectural character of the campus.

- **Community Values**

  Moderately low response; the new science building serves primarily the students. However, community attendance is envisioned for some guest lecture programs.

MEASURING QUALITY CONFORMANCE

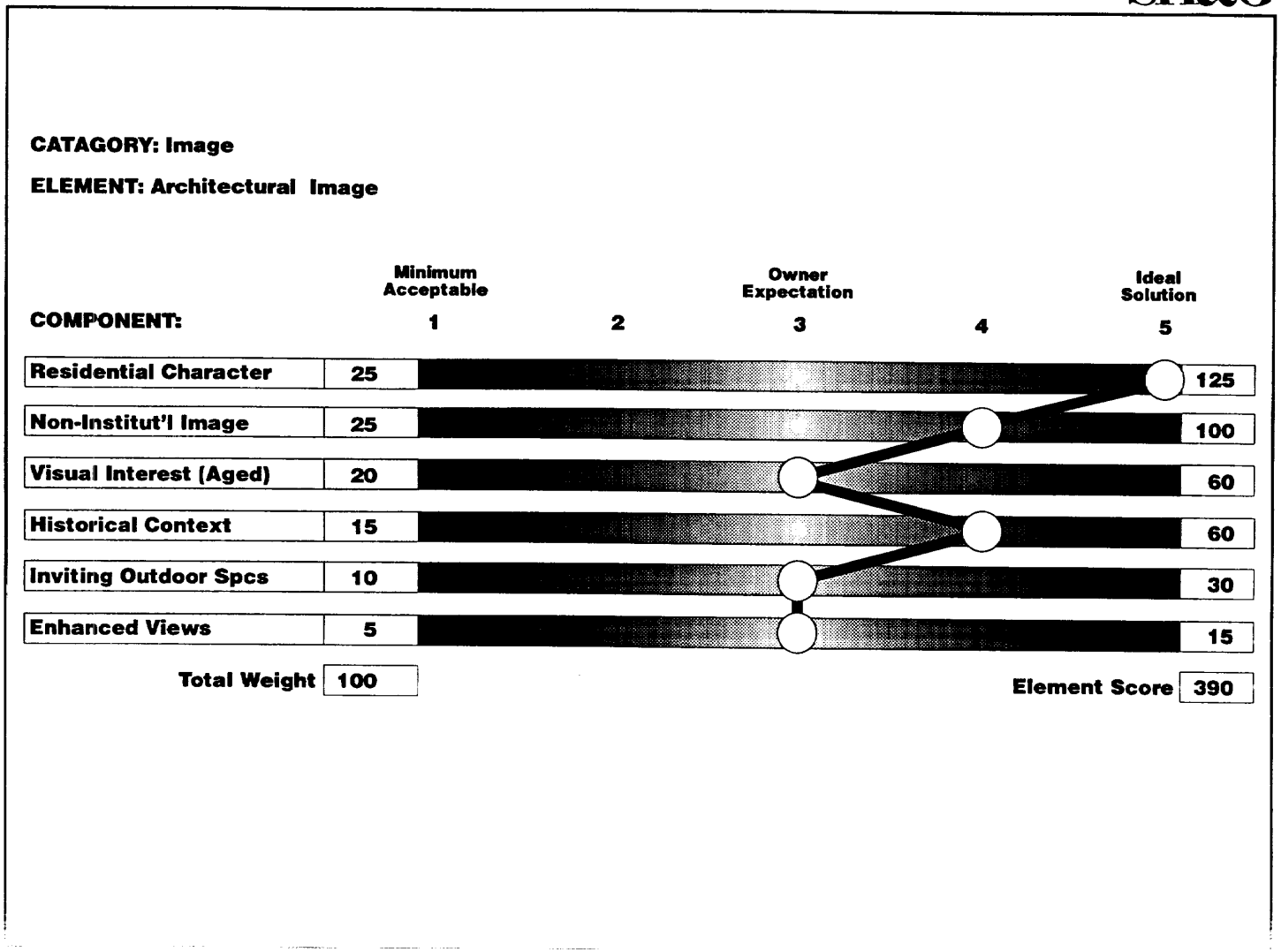
Measuring quality begins during the design of the project. Costs, for example, are normally estimated (measured) during the schematic, design development, and construction documents phase of design.

In a similar way, the other elements of the quality model are used to "measure" the project design for conformance. The measurement scales that were prepared during the quality modeling effort are used to assess how well the actual design meets the predefined "owner expectations." In some cases the design may not only meet the "owner expectations," but may also come close to achieving the "ideal solution" described on the quality component measurement scales. Other quality components may only be "minimally" satisfied by the actual design solution. The purpose of measuring quality is to determine if the design is conforming to the owner's original quality expectations. Just as with cost, if the design does not minimally achieve the quality objectives, then management action is required to make adjustments.

Figure 4 illustrates the measurement of the element "architectural image" for a health care facility located in a historic area of Washington, DC. The weighting, measurement and resulting score are calculated based on the quality component measurement scales developed earlier. Other design alternatives are also measured using the same component scales.

Element/ Component Scores Alternate Scheme "A"

SH&G



Managing project quality is achieved in part by holding a series of value engineering workshops which

occur at each of the project design milestones including: schematic, design development, and occasionally, construction documents. This workshop approach permits team problem solving and consensus. Participants also represent the five points of view described earlier.

During the 3-5 day VE workshop, participants creatively generate a wide variety of alternatives to enhance the project design to come closer to meeting the quality conference expectations defined in the quality modeling effort. Study areas are selected based on the results of the quality conformance measuring effort. For example, if some space functional adjacencies were not achieved resulting in reduced "operational effectiveness," then the VE team would explore alternate layouts to improve this quality component.

COMPUTER SIMULATION: VeNTURE

A custom, PC based simulation program called VeNTURE is used to assess "what-if" ideas suggested by the VE team. This rapid feedback of results permits "real-time" decision-making to occur by the participants for group consensus. Following the workshop session, a management report is prepared which summarizes the recommendations for quality enhancement for the project. These management recommendations are then incorporated into the design by the A/E team during the next phase of the project.

LESSONS LEARNED

The VE technique of "Quality Modeling" is very useful in defining, measuring and managing owner project quality expectations. Application of the quality modeling approach on a variety of facility types during the past four years has resulted in the following observations:

- The quality modeling process provides an opportunity for the owner's team to collaboratively establish project expectations involving members of differing perspectives.
- Quality modeling often identifies "issues" that would have not been otherwise discovered until late into the design and construction process.
- Left without a method for measuring conformance, building area typically increases 5% to 10% during the design process.
- Once a project is bid, area (GSF) reduction will only decrease costs by 50% of the bid $/GSF.
- Resolution of cost overruns does not always have to be dealt with by decreasing scope.
- Without a method for measuring conformance, net to gross ratios tend to slip 5% to 10% during the design process.
- Undefined site components and building "special" foundation, architectural, mechanical and electrical systems represent the largest risk to budgets.
- Design/Build does not save money, it simply limits the contractor's risk by limiting the owners' options regarding project quality.
- Traditional project delivery methods which do not stress criteria development during the planning phase tend to define scope requirements through an iterative (and expensive) design process.
- Projects without a managed emphasis on meeting owner "quality expectations" during the design process, do not achieve the best value for the project budget.

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