# Assessing the System-Wide Impacts of Automated Voice Response Customer Service Technologies

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## Introduction and Problem Background

Between 1994 and 1995 the Office of Regulatory and Management Assistance (ORMA) of New York State became interested in reengineering the processes whereby it interacted with the public. Specifically, the agency was having difficulty responding to phone inquiries for business permits in a timely way and was proposing that business permit information be integrated into an automated voice response customer service system. ORMA approached the Center for Technology in Government (CTG), a research and development unit of New York State Government, requesting that such a system be developed on a prototype basis and evaluated for feasibility.

CTG, working with Precision Systems, Inc., developed a functioning prototype for ORMA's proposed solution and proceeded to evaluate its effectiveness, using a multi-method evaluation typical of CTG's approach to prototype evaluation (Andersen, Avery, Hyde, and Kelly, 1995). A team of managers was convened in a group modeling session to estimate a cost-benefit model for a fully functioning customer service system (Andersen and Rohrbaugh, 1994). A formal experiment was conducted in which graduate students were asked to research a business permit problem by one of three methods -- (1) calling into the present ORMA operator assisted system, (2) calling into the new prototype system, or (3) doing the research without knowledge of ORMA (Andersen, Avery, Hyde, Kelly, and Kim, 1995). Finally, a formal system dynamics simulation model was constructed to assess what would be the overall impact of a fully functional system on the overall business processes of ORMA if such a system were to be purchased and installed (Mojtahedzadeh and Andersen, 1995). Using an approach first proposed by Wolstenholme (Wolstenholme, Henderson, and Gavine, 1993) this simulation evaluated the potential impacts of business process redesign on the overall organizational sub-system in relatively early design and testing stages of the project.

## Research Questions for This Paper

This paper has two purposes. First it presents some of the technical details of the system dynamics simulation model created for the ORMA project. This model was designed to answer detailed questions about customer response dynamics within ORMA. What are the impacts of various types of equipment capacity constraints on the number of customer hang-ups? What is the appropriate size of various system components (e.g., phone lines or computer ports) needed for various customer volume scenarios? How do system components interact to drive overall system performance? How should managers "grow" the customer service processes through various modes of system behavior?

The second part of the paper looks into the role of simulation as one of several evaluative and design tools being used in a business process redesign exercise. What types of questions are best answered by system simulation in the evaluation of technology-intensive business process redesigns? How does simulation best fit in with other types of evaluation and design technologies such as experiments, customer surveys, interviews, and decision conferences?

## A Simulation of ORMA's Business Permit's Assistance System

This section of the paper briefly describes the structure and behavior of a simulation model that examines the technical and organizational consequences of installing a prototype automated business permit system into the business processes of the agency. Figure 1 is an overall block diagram of the agency's system of processes for responding to customer inquiries. The call processing system indicates how ORMA handles calls into the system from call placement to call completion. The system consists of three sectors: (1) callers, (2) ORMA's phone system, and (3) system performance. The caller sector reflects citizen demand for information delivery. The phone system sector drives system performance based on the balance between calls and call-processing capacity (i.e., phone line, port, and operator). The system performance sector, on the one hand, provides a basis for making capacity expansion decisions. On the other hand, it provides information to the reputational dynamics which drives long term growth in ORMAs call volume. The reputational effect is not formulated in the model; instead, three scenarios of base caller volume are introduced to capture the potential effect of system performance on customer satisfaction and, therefore, on citizen demand.

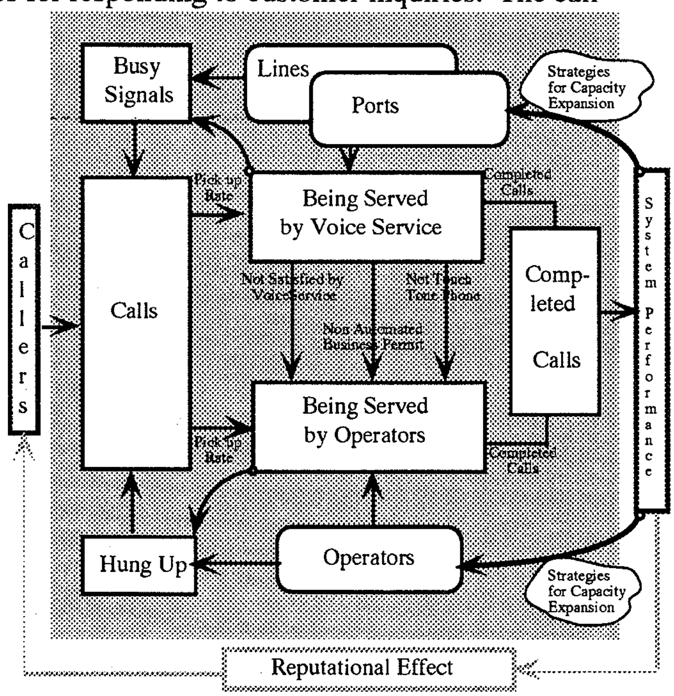

Figure 1: ORMA's Call-Processing System

Evidence analyzed in the simulation experiment indicates that under the current system, ORMA's information dissemination performance by phone is significantly lower than it could be. As Figure 2 depicts, waiting time for an operator remains at its minimum until 11:00 AM, and then increases rapidly to six minutes. Port utilization reaches one around 10:30 AM, when operator utilization and port utilization are around 50 to 60 percent indicating the number of ports is much smaller than needed to support the number of telephone lines and human operators which causes the voice service to become ineffective. By the end of the day, the numbers of total calls, completed calls, and attempts per completed call each attain their steady-state value. For 150 completed calls, 700 calls were placed. Each caller, on average has made almost five attempts to get through the system.

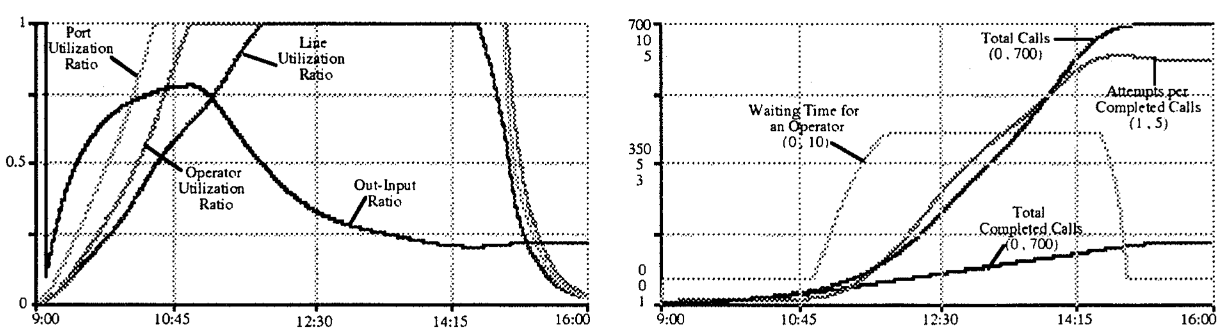

Figure 2: Base Run - Simulation of a Typical Day

Figure 4 presents a matrix of results from multiple runs of the simulation model examining the impact of different strategy in call-processing capacity expansion on the system performance under three scenarios. Under the base volume (150 callers per day), implementing the new system hardware is equivalent to hiring one operator. When the call volume is twice the base volume (300 callers per day), installing the new system hardware becomes unavoidable, and hiring additional operators does not compensate for the lack of new system hardware. However, hiring one operator is equivalent to automating business permit information, when the the new system hardware is installed. Under the third scenario (450 callers a day), improving system performance requires an even greater number of telephone lines and ports than what the new system hardware offers.

| | Scenarios | Policies | | | System Performance | |
|---|---|---|---|---|---|---|
| | Number of Callers per day | New Phone System | Operators | Automate Business Permits | Attempts per completed calls | Waiting time for an Operator |
| Base Run | 150 | No | 3 | No | High | High |
| Run 1 | 150 | No | 4 | No | Low | Low |
| Run 2 | 150 | No | 3 | Yes | High | High |
| Run 3 | 150 | Yes | 3 | Yes | Low | Low |
| Run 4 | 150 | Yes | 3 | No | Low | Low |
| Run 1 | 300 | No | 5 | No | High | Fairly Low |
| Run 2 | 300 | Yes | 5 | No | Low | High |
| Run 3 | 300 | Yes | 5 | Yes | Low | Fairly Low |
| Run 4 | 300 | Yes | 6 | No | Low | Low |
| Run 1 | 450 | Yes | 6 | No | High | High |
| Run 2 | 450 | Yes | 8 | No | Low | Less High |
| Run 3 | 450 | Yes | 7 | Yes | Low | Less High |
| Run 4 | 450 | Yes | 6 | Yes | Fairly Low | High |

Figure 3: Summary of Results of Simulation Model

## The Role of Simulation in Assessing Automated Customer Service Technologies

Evaluating a redesign of business processes supported by a new technology involves at least three types of questions --technical questions about the technology itself, efficiency questions about the overall cost and performance of the system, and effectiveness questions that get at quality of service issues. As shown in Figure 5, the various evaluation methods used in this study all address these three types of questions. However, each evaluation method addresses different aspects of the overall problem. For example, with respect to technical issues, the prototype answers directly the question, can complex permitting information be automated and what are the technical problems involved with this implementation? On the other hand, the experiment can systematically evaluate how customers react to specific technical components of the system (such as the number of levels in the response hierarchy or the quality of the recorded voice). Finally, a system dynamics simulation model can assess the size and scale of needed components when a full-scale system is installed into existing or modified organizational processes. Figure 5 suggests that process simulation models are best used as one of a suite of analytic tools in addressing this type of business process redesign problem.

| Type of Question | Prototype | Cost & Performance Group Conference | Experiment and Survey | Process Simulation model |
|---|---|---|---|---|
| Technology Questions | *Can complex information be automated? What are the technical problems and their solutions?* | What are the anticipated customer volume by type or transaction? | How do customers react to specific technical components? | What size components are needed for various volume scenarios? |
| Efficiency Questions | What are hardware and software costs? | *What are the unit costs for types of transactions? How much staff time per type of transaction? What are simple cost-to volume trade-offs?* | How long did customers have to wait? | *How do system components interact to derive performance? Long term reputational effect? Managing mode shifts?* |
| Effectiveness Questions | What are the best "look and feel" for customers? | | *Do customers like using the system? What is customer willingness to pay for services? What are extended products and benefits from the system?* | Impact of capcity costraints on customer waiting time? |

Figure 4: Multi-Method Approach to Prototype Evaluation

Whereas Figure 4 emphasizes the differences in purpose and outcome of various evaluative approaches, Figure 5 suggests that at another level of abstraction, all of the evaluation technologies share a number of common features. All four evaluation approaches discussed in Figure 4 -- prototypes, cost and performance group conferences, experiments with customer reaction, and process simulation models -- strive to create an object or artifact (a prototype, a group model, or a system simulation model) from which system managers can learn lessons about their system. Each approach involves steps to evaluate the object of learning as well as steps to design a next stage in the overall process.

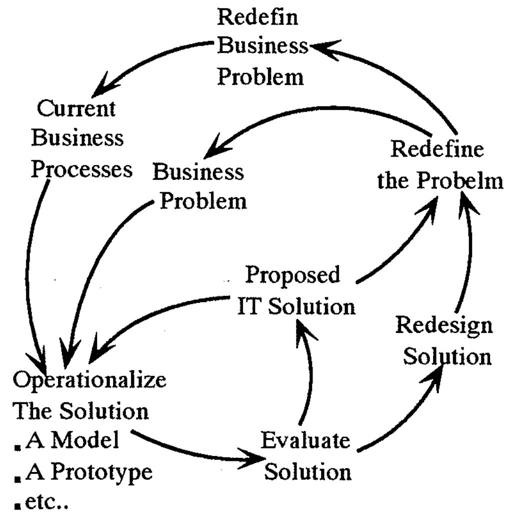

Figure 5: The learning loop

Figure 5 makes the point that this learning loop of evaluation and design can occur at several levels. The innermost learning loop in Figure 5 involves proposing a technology-based solution (as a prototype or as an overall process simulation model) and evaluating that technical solution. The evaluation of the solution can lead to a redesigned solution which at the next stage of the project yields a new proposed solution. However, as shown in Figure 5, the evaluation of the solution can often yield a redefinition of the problem being solved. For example, in the ORMA example, the initial problem centered on whether or not complex permit information could be automated. Evaluation of the prototype concluded that it could, but that a key question was at what volume of customer calls would such automation be cost justified? Redefining the problem often leads to an examination of the business problem being solved and a redesign of the business processes for the system as a whole. In the ORMA case, evaluation of the process simulation model revealed the potential positive loop between customer satisfaction and the volume of incoming customer inquiries. This loop implied that a very successful automated system would generate sufficient customer satisfaction and hence repeat business (as a free public service) that the very success of the system would swamp it in the future. The solution to this problem involved a redesign of the types of services and the prices for those services being offered by ORMA.

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