Pervasive Computing Puts Food on the Table

Vince Stanford

EDITOR'S INTRODUCTION

Why would a restaurant owner replace 50¢ paper order pads with a wireless network, palmtop PDAs, touch screen terminals, and back-office servers? After all, order pads don't need systems administration, present a user interface everyone understands, and are cheap. Imagine your server navigating menus while customers try to decide on their meals, change their minds, and shout their orders over the general din. Sounds like a recipe for disaster rather than good service, right? To find out, I talk to Alex Malison, chief executive officer of Action Systems Incorporated, who has deployed such a system to operating restaurants, and to owners and food servers, who actually use it on the restaurant floor.

A word of caution: I found the restaurant owners so enthusiastic that it was hard to get a balanced view from them. Maintain a healthy skepticism as you read, even though your editor cannot avoid conveying the enthusiasm of those interviewed. Caveat emptor should always be a guiding principal in evaluating commercial products. —*Vince Stanford*

We are at the Royal Mile Pub in Silver Spring, Maryland. It is a restaurant and bar with about 20 tables specializing in a wide selection of beverages. Its dinner menu has specials along with many regular food items. Alex Malison is hosting a late evening dinner party for his sales representatives so they can see the order entry system in operation and thus explain it to restaurant owners. Sitting in on the presentation, I note quickly that he has replaced the little green order pads we've all seen a million times with iPaq PDAs connected to the kitchen using IEEE 802.11 wireless networking.

FOR CUSTOMERS, FASTER SERVICE, FEWER ERRORS, AND CALM TECHNOLOGY

I am skeptical about the viability of a small-screen window manager in such a chaotic environment. I think about navigation through drink menus, then food menus, and the midstream order changes, meaning the whole process must be amended. Is another case of user interface design failure brewing at the pub? Ann Marie Diogo, our server this evening, approaches and greets us while taking a PDA tethered to her belt from her pocket. The backlit screen faintly illuminates her face in the dimly lit pub; she asks us what we would like to drink. "Club soda with a twist of lime." A couple of pen strokes, a brief glance at the screen, and she continues. "Corona Light, no twist." Next. "Coors on tap?" A couple more pen-strokes and she moves to the next table.

Her attention scarcely seemed on the PDA at all. When she returned with the drinks, she took our dinner orders with equal facility. She used only a few pen strokes and didn't seem to navigate among screens. Mostly she had just glanced at the screen to verify the correct item had appeared. Clearly, careful attention had been paid to the interface's usability. She hadn't been running her computer at all, just taking the orders. Courtesy of 802.11, the orders appeared immediately on screens in the kitchen and bar, so she moved to the next table rather than hurrying off to place the orders with the cooks and bartenders. Having seen many dysfunctional attempts at automating routine tasks using pervasive devices, I was surprised, instead, to see an example of Weiser's "calm technology" working at our tableside.

FOR OWNERS, LESS WASTE, BETTER INVENTORY, AND LOWER COSTS

As Alex introduced me to Ray Morrison, the Royal Mile Pub's owner, he remarked with a wry smile that I should have asked if he was giving the restaurant owner an incentive to emphasize the positive in the interview. Ray assured me that had been given no incentives, but was simply very positive about the system's effect on his business. With the order system costing about $30,000 to install, I wondered how it could pay its way compared to order pads and pencils. "Fewer errors, better inventory control, and smaller payrolls," Ray said and smiled.

Food and beverages account for about 40 percent of his costs, with about

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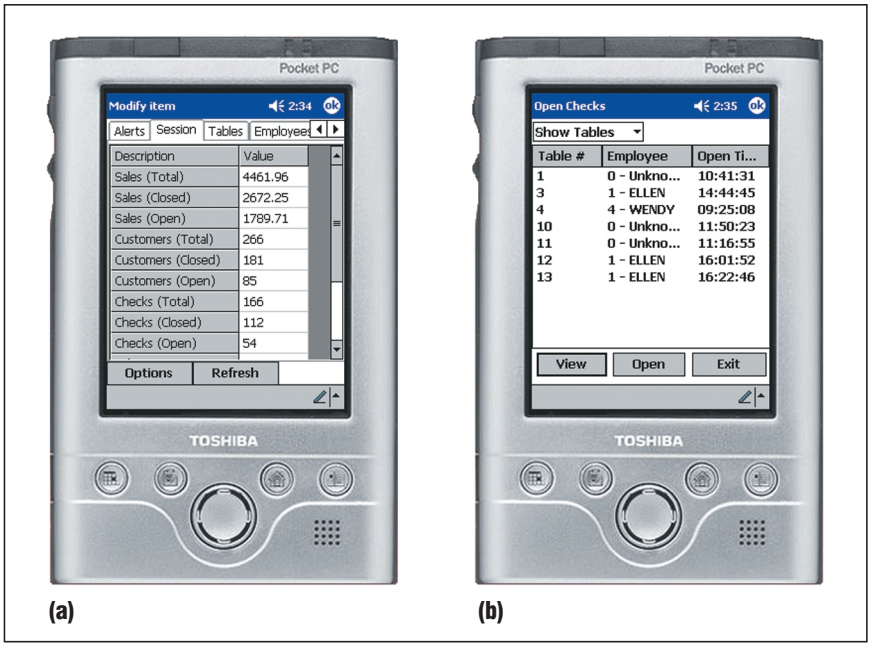

Figure 1. Management functions for monitoring sales and open checks in real time, which allows quick verification of order fulfillment: (a) screen to monitor the day's overall business; (b) screen to check table assignments.

10 percent of orders having errors when his staff used old-fashioned order pads. These errors meant that many meals prepared in the kitchen were wasted, adding significant costs to his operation. Also, serving customers with the wrong meals caused dissatisfaction, sometimes requiring management attention or, more costs in free meals. Ray smiled again when he said that the pervasive order system had reduced his error rate from several meals per night to about one every two nights. Now, on many nights all food and drink items are accounted for on the checks, and all meals are prepared correctly. "I only wish we could get the bartenders to function at the same level as the wait staff does," he said.

As another benefit, now only three servers are needed, rather than the four to five previously required. Cutting his core staff requirement means lasting cost reductions and lower overhead for his operation. Also, the data-entry station on the serving floor for processing credit card charges previously needed three screens to handle the traffic. He now needs only one. This freed scarce space on the serving floor while saving power costs.

As orders transmit, they are processed against the inventory database, letting Ray track raw material purchases against the food orders and identify waste or other delivery and processing problems. This capability is especially important at the bar, where inventory control is often a special issue. Also, the servers now spend more time on the floor with the customers, affording more selling opportunities. "Sales of wines are up 12 percent, desserts are up 14 percent, and I can turn the tables faster so I sell more meals," he told us. Overall, his revenue is up about 15 percent, making the system a commercial success.

Concerning training for the nontechnical servers he employs, Ray said that, "Yes, there is a game included in the system that teaches the basics of how to enter orders. It takes experienced servers about 15 minutes to get the idea, because it works the way they already do. I am a happy convert," he said as he returned to supervising operations.

Also, as Figure 1 shows, the system has operations management functions that let the owner monitor the business in real time.

FOR SERVERS, FEWER STEPS, FEWER PROBLEMS, AND MORE MONEY

Our server, Ann Marie, has found that the pervasive system has simplified her job. She used to walk to the bar, place the order, go on to other tasks, and go back to the bar when the drinks were ready. Likewise, meal orders required her to make one roundtrip to place the order on a revolving wheel that the chef would rotate into the kitchen. Later, when touch screens came along, she still had to walk to the screen and enter the order, item by item, using its menu system to transmit it to the kitchen. Sometimes errors occurred in the transcription process, making for unhappy customers when the wrong order came up, for stressful situations, and lower tip income. With the new system, she enters the data at tableside, checks it, and transmits it to the bar and kitchen over wireless.

She finds that the system has eliminated most errors—and she is happy to see them gone. Also, she can spend more time with each customer and handle more tables because she makes half as many trips out of the serving area. So she has more pleasant customer relationships and higher income. Finally, the kitchen becomes aware of orders immediately, so the food arrives more quickly. The system also totals the checks, eliminating errors in arithmetic. The PDA interface keeps her posted on the status of menu items that are unavailable because the kitchen has run out of ingredients; getting that information to her customers immediately has reduced another source of their dissatisfaction. Asked if the interface is hard to learn and use, she smiled and said, "No, and it would be hard to go back to pencils and order pads now."

FOR THE ARCHITECT, DESIGN CHALLENGES

In observing that Ann Marie had taken our orders with minimum navigation, I asked Alex to discuss how he had achieved this apparent ease of use. He realized from the start, he said, that too many menu layers would make a cumbersome interface—and being "cool" because it was a PDA couldn't make up for functional deficiencies. So simply porting the touch screen menu system from his desktop point-of-sale system—with its hierarchical approach, detailed screens, and high cognitive load for the server—would be a bad design concept. So he decided to develop an interface designed from the outset to use PDA handwriting recognition to implement a system that would mimic the strengths of the existing written order pad system. Most experienced servers know the menu and make heavy use of abbreviations. His system would take advantage of those skills.

Analyzing the existing ordering process

To remind the development team that the goal was to make the user interface as simple to use as a pencil and pad, Alex started the design process by taping a green order pad on the whiteboard in his development room. Next, he developed a detailed list of the old order pad's benefits and disadvantages, detailing how it is used at each step in the process and listing what is captured there. He wanted to understand its strengths as well as its weaknesses. It would not justify new capital investment by the restaurant owners if he only equaled the convenience and usability of the existing method. His design goal was to improve every major task in the workflow significantly. Also, to identify targets of opportunity for additional enhancements, he discussed the restaurant's operational problems with the owners.

He considered the work processes, step by step, as a server takes an order, verifies it, transports it to the bar and the kitchen, transcribes it into the kitchen ordering system, checks for previous orders that have come up, serves the food, and processes payments electronically or in cash. Particularly, he tried to observe where errors occurred and the costs they incur. Then he aligned these tasks against new capabilities such as wireless transmission, online consistency checking, tracking guests in seats at the tables, and coordination with the back-office inventory management system. He wanted to use the new capabilities to make a system that worked for all the stakeholders in the transaction—customers, servers, and restaurant managers alike. The benefits should include lower costs and overhead for the owner, higher revenue and easier customer relationships for the servers, and faster, more reliable service with better attention for the customers.

With this analysis done, he wrote key requirements for the order system to offer improvements in

- Reduced writing for the servers afforded by the abbreviation and completion feature
- Reduced errors due to online edits and eliminating unnecessary transcription steps
- Increased time in the serving area by transmitting the order using 802.11, allowing fewer roundtrips for the servers
- Improved back-office functions for inventory control and process monitoring

Also, new characteristics and limitations would have to be considered, such as battery life (with full-shift endurance essential) and theft (high-end PDAs are inviting targets, where you couldn't give order pads to a thief). To address these problems, Alex selected an extended-life battery cradle, supporting a full shift of operation with intensive backlighting, 802.11 networking, and a strong tether to secure the PDA to the server's belt. A color screen with effective backlighting for the dimly lit conditions of restaurant evening shifts was also essential. A high-end rugged Pocket PC-based PDA, with good printed character recognition, emerged as the best candidate to meet these requirements.

(The "Half-Hour Lunch" sidebar recounts another restaurant owner's experience with a competing system.)

Understanding the work environment's stresses

Alex found that the only way to make the interface comfortable for servers taking orders at tableside was to let them do things as they were already doing with the pencil and pad. At tableside, servers face a challenging environment. They are in front of customers answering questions, making eye contact, and offering suggestions, so the user interface needs to be as close as possible to what they are accustomed to using. It cannot take much attention to operate the PDA or the server will be distracted and unable to respond to customers. Directly porting larger touch screen interfaces, with multilevel menus that require too much attention to manage, was out.

Relying on what servers already know

Training for people with limited information technology backgrounds also had to be considered. For example, printed character recognition is a key capability for this user interface. Alex quickly ruled out PDAs that ran the Palm OS and its Graffiti recognition system, because they require users to learn how to print an idiosyncratic character set. Alex found that servers just wanted to take orders and thought they had learned to print properly in elementary school. So pen input that can recognize letters as commonly printed was a nonnegotiable requirement for his target platform, eliminating Graffiti-based PDAs, whatever their other virtues.

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HALF-HOUR LUNCH

I talked with Todd Dukes, the owner of Argus Food and Spirits, which is housed in Madison, Wisconsin's oldest commercial building, constructed in 1852. It was renovated in the late 1980s, has two serving levels and a patio, and seats about 130 people. The historic building offers crowded quarters for tables, so servers had to take orders to the kitchen, on the lower level, in batches. According to Todd, his greeting and food preparation times were good, but the order batches meant an average 12-minute wait time from seating to serving. Because Madison, as Wisconsin's capital, has many state workers who have just a half an hour for lunch, he was losing his lunch trade to faster competitors, with lunch business falling from 25 percent of gross revenue to about 14 percent over the past year.

Something had to be done, so Todd investigated wireless point-of-sale systems. Once he installed the ASI WPOS system, he could serve his tables with an average four-minute wait time, down sharply from the previous 12. After operating the system for the past four months, his lunch business has recovered to about 18 percent of revenues and is still rising. Labor costs on the floor and in the kitchen have fallen, just as in the Royal Mile Pub.

The decision to invest $30,000 in new technology was not an easy one. The ASI system Todd selected was at the lower end of the price range, and service was offered as part of the system price, where it was extra cost (about $100 per hour) for other systems he evaluated. He rejected one system that used a tablet computer with a 10.5-inch display, because the servers could not carry it and the food they were serving. So there can be too much of a good thing, with portability taking precedence over the larger screen wearable computers favored in the heavy industries we covered last installment.

Todd was so ebullient that I bluntly asked him to please tell me the problems he encountered with the system. He said that power fluctuations in the building now caused server outages, but he has installed UPS backups. Also, he wants to process credit card charges at the table, but the system does not support that capability.

"This system has been fantastic for my business," he said, relentlessly returning to the positive. He had planned for a two-year payback on the investment, but it will actually be less than 18 months. "Also, I can chain requests, such as the side orders to go with a sandwich so that the server will always remember to ask."

For training, he has found that an experienced new hire needs just 15 minutes of training. "Then just set her loose on the floor. She might stumble once or twice, at the beginning of the day, but would be just fine."

To keep training to a minimum, this interface would rely on what its intended user community already knows. The Royal Mile offers over 1,100 food and beverage items, with several hundred optional modifiers. For example, the menu has over 80 kinds of Scotch, as just one beverage among many. Servers like Ann Marie, who has worked at the Royal Mile for over five years, have the menu items on active recall. Alex relied on this level of knowledge to flatten and simplify the interface. While it might seem obvious that servers knows their product line, the sheer number of choices and modifiers that customers can make is daunting.

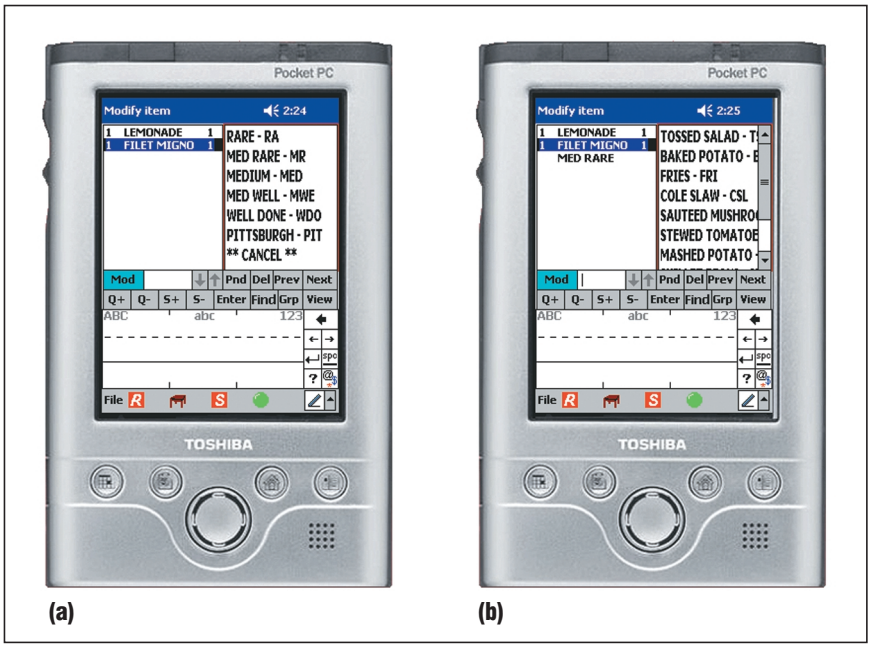

Figure 2. Fixed geometry data-driven interface with command entry at the bottom of the screen: (a) ordering a filet mignon; (b) ordering the side dishes.

Paper is flat; the pervasive ordering interface should be too

As one of its features, the order pad is flat. Items from a single order can be written without repeatedly flipping between different pages in the pad as the order progresses. So Alex decided to design his system to approximate this characteristic. He flattened his menu trees by using an abbreviation system, allowing many more choices than a touch screen button layout, just as

WIRELESS POINT-OF-SALE SYSTEMS

PDAs with wireless networking to implement point-of-sale capability exemplify how pervasive computing can push the benefits of information technology to the tableside. The Action Systems Restaurant Manager I've described is only one of several that are available, and they all make similar claims, so interested parties should conduct their own detailed comparisons, which space does not permit here. They all operate as part of a more complete restaurant management system that can transport the orders to the kitchen, bar, inventory, and reporting systems. A few of these include:

- *Action Systems Inc. Restaurant Manager (www.actionsystems.com).* As our article describes, this system is based on PDAs using the Microsoft Pocket PC operating system and can be integrated other ASI components for inventory and kitchen management.
- *Ameranth 21st Century Restaurant (www.ameranth.com).* Based on PDAs using the Microsoft Pocket PC operating system with 801.11b wireless networking, using a third-party point-of-sale processing server in the back office.
- *Micros Restaurant Enterprise Series (RES) 3000 (www.micros.com).* Based on Pocket PC, with 802.11, and integrating with the company's 9700/8700 Hospitality Management Systems, with components for product, labor, and financial management, and restaurant operations.
- *Wireless Waitress (www.thewirelesswaitress. com).* Based on Pocket PC and Viewsonic Viewpad 1000 terminals and supporting order printing, kitchen display, and employee scheduling modules (see Figure A).

(1) (2)

Figure A. WPOS terminals by (1) ExecuTouch and (2) The Wireless Waitress with touch screen button interfaces.

servers had done with the paper order pad. The completion system narrows choices rapidly, even with 1,100 items, so just a few characters can usually identify an item. For example, entering "cs" might result in a choice list containing "club soda" and "club sandwich." The choice is disambiguated by continuing the last word of the item phrase, for example, by extending to "csa" for the club sandwich and "cso" for the club soda.

Segmenting the interface

The need to select from 1,100 menu items makes this an important issue. Too many menu levels could double, or even triple, the pen strokes needed. And when a customer changes his mind, the operation would be even more complex. Alex took advantage of the segmented pen entry fields on the PDA, with its separate areas for capital letters, lowercase letters, and numeric data, by assigning command abbreviations to capitals, food and beverage items to lower case, and quantities to numeric areas. For example: commands like "customer count," would be entered as "CC" in the capitals area. Alex observed that the more regular the interface geometry the more usable it would be under demanding conditions.

These assignments provide a clear context for a server who orders items by printing in one area, listing quantities in another, and making commands in another, always at the bottom of the screen. Alex also segmented the display area with the upper left side for items already ordered and the upper right for items requiring modifiers and additional decisions. By segmenting the interface, as well as flattening it, he let the server know where to look on the screen at all times during the ordering process, as well as where to write.

Figure 2 shows the ordering process for a filet mignon. The decision area in the upper-right quadrant is dependent on the active data item on the upper left. The data item can have several lists of dependent decisions, starting with preparation instructions and proceeding to the possible side orders. The order grows on the left, as decisions lists cycle through the right. This fixed geometry lets the server easily manage the interface while at tableside. The "Wireless Point-of-Sale Systems" sidebar shows other similar approaches.

APPLICATIONS

ASI RESTAURANT MANAGER WIRELESS POINT-OF-SALE PERVASIVENESS REPORT

Because this issue's department focuses, to a considerable degree on the ASI WPOS module of the company's Restaurant Manager System, we are presenting a Pervasiveness Report. This particular system is focused on service delivery at the tableside using a classic small screen wireless pervasive device. The factors are designed to cover a wide range of issues, so a pervasive system might have high scores in areas where it has features but not address all areas. The purpose of the report is to provide a contextual summary, and thus a view of the system within the broad context of possible pervasive computing features. Readers are welcome to correspond with the Department Editor to refine and clarify these factors for future articles.

TABLE A
Pervasiveness report for MSI WPOS tableside order system

Category	Function	Rating
Computing infrastructure	Well integrated with enterprise servers	High
Wireless networking	Exploits 801.11 well	High
Mobile computing devices	Wireless PDAs central to application	High
Device discovery	Predefined network addresses	Low
Service discovery	Predefined application specific access	Low
Multimodal user interfaces	Screen and pen	Low
Pervasive databases	Well integrated with enterprise database management system	High
User authentication	Multi level passwords	Medium
Secure networking	801.11 wired equivalent privacy	Low
Task integration	Essential to task	High

Intellectual property

This interface's developer considers it an advantage over alternative approaches seen in competing systems. Accordingly, he applied for patent protection on what he believes to be the innovative design and utility features of the interface. Design Patent Number D464,361 "Graphical user interface for a handheld computer," was allowed on 15 October 2002, and additional utility patents are pending. For information on this and other current interface patents, check the US Patent and Trademark Office Web site (www.uspto.gov). The USPTO online database offers over 80,000 results in response to a patent search of "computer and user and interface." While it is impossible to evaluate the relevance of these patents to any particular project, clearly there is a substantial body of patented intellectual property in the field of user interface design that potential product developers should consider.

Business enterprises gain the greatest benefits from pervasive computing when pervasive devices are used to push information technology out to the edges of the business where work is done or services actually rendered. Integration with the enterprise database and inventory control systems is key to realizing cost reductions, improved workflow, and inventory and personnel management. In previous installments of this department, we have seen this theme repeatedly at Elite Care, Kaiser Permanente, McKesson, Northwest Airlines, and Bath Iron Works. This seems key to the value proposition pervasive systems offer to business.

As Robert Heinlein pointed out a half century ago, every technology typically goes through three stages:

> *First, a crudely simple and quite unsatisfactory gadget; second, an enormously complicated group of gadgets designed to overcome the shortcomings of the original and achieving thereby somewhat satisfactory performance through extremely complex compromise; third, a final stage of smooth simplicity and efficient performance based on correct understanding of natural laws and proper design there from*

As we've seen, restaurant servers and operators liked a design that captured the previous manual system's strong points, such as flattening the menu hierarchy by duplicating the abbreviation system long used in the previous solution. They also wanted workflow benefits and data-management improvements achieved by transcending the older, simpler "stage one" technology of paper and pencil, using automatic capture, summary, and wireless transmission of transactions across the business. The desktop point-of-sale systems and the associated transcription problems and extra steps could be taken as "stage two" of the technology, with too many moving parts and some bad compromises, but still having benefits. The pervasive, workflow- and management-process-oriented, wireless version that is well integrated into the enterprise database arrives at "stage three" or "calm" technology. P