exhibit 6A.17

The Dining Area

	NO SMOKING	SMOKING	DRINKS	SALAD BAR	WAITING AREA
Cash register	U	U	I	I	A
No smoking	—	X	E	E	U
Smoking	—	—	I	I	U
Drinks	—	—	—	U	U
Salad bar	—	—	—	—	X
Waiting area	—	—	—	—	—

SOURCE: THIS CASE WAS PREPARED BY DOUGLAS STEWART. IT IS NOT INTENDED TO SHOW PROPER OR IMPROPER HANDLING OF FOOD.

CASE: DESIGNING TOSHIBA'S NOTEBOOK COMPUTER ASSEMBLY LINE

Toshihiro Nakamura, manufacturing engineering section manager, examined the prototype assembly process sheet (shown in Exhibit 6A.18) for the newest subnotebook computer model. With every new model introduced, management felt that the assembly line had to increase productivity and lower costs, usually resulting in changes to the assembly process. When a new model was designed, considerable attention was directed toward reducing the number of components and simplifying parts production and assembly requirements. This new computer was a marvel of high-tech, low-cost innovation and should give Toshiba an advantage during the upcoming fall/winter selling season.

Production of the subnotebook was scheduled to begin in 10 days. Initial production for the new model was to be at 150 units per day, increasing to 250 units per day the following week (management thought that eventually production would reach 300 units per day). Assembly lines at the plant normally were staffed by 10 operators who worked at a 14.4-meter-long assembly line. The line could accommodate up to 12 operators if there was a need. The line normally operated for 7.5 hours a day (employees worked from 8:15 A.M. to 5:00 P.M. and regular hours included 1 hour of unpaid lunch and 15 minutes of scheduled breaks). It is possible to run one, two, or three hours of overtime, but employees need at least three days' notice for planning purposes.

exhibit 6A.18

A Prototype Assembly Line for the Subnotebook Computer

STATION	OPN. #	TIME (SEC)	DESCRIPTION OF OPERATIONS
1	1	100	Lay out principal components on conveyor
110 sec	2	6	Peel adhesive backing from cover assembly
	3	4	Put screws for Opn 8 in foam tray, place on belt
2	4	50	Scan serial number bar code
114 sec	5	13	Connect LCD cable-1 to LCD-printed circuit board (PCB)
	6	16	Connect LCD cable-1 to LCD display panel
	7	13	Connect LCD cable-2 to LCD-PCB
	8	16	Screw LCD-PCB into cover assembly
	9	6	Put screws for Opns 13, 16 in foam tray on belt
3	10	26	Install LCD display panel in cover assembly
101 sec	11	10	Fold and insulate cables
	12	13	Install LCD frame in cover assembly
	13	23	Screw in frame
	14	6	Place PCB-1 in base assembly
	15	6	Install CPU bracket on PCB-1
	16	13	Screw CPU bracket into base assembly
	17	4	Put screws for Opn 23 in foam tray

Excel: Toshiba

exhibit 6A.18

(Continued)

STATION	OPN. #	TIME (SEC)	DESCRIPTION OF OPERATIONS
4	18	15	Connect ribbon cable to hard disk drive (HDD)
107 sec	19	11	Connect ribbon cable to PCB-1
	20	8	Place insulator sheet on HDD
	21	8	Stack PCB-2 on PCB-1
	22	8	Stack PCB-3 on PCB-1
	23	13	Screw in both PCBs
	24	6	Install condenser microphone in holder
	25	13	Connect microphone cable to PCB-1
	26	8	Tape microphone cable down
	27	13	Connect backup battery to PCB-2 and install in base
	28	4	Put screws for Opn 31 in foam tray
5	29	6	Install support frame on base assembly
103 sec	30	13	Stack PCB-3 on PCB-1
	31	6	Screw in PCB-3
	32	8	Install Accupoint pointing device pressure sensor
	33	11	Connect PCB-5 to PCB-2 and PCB-4
	34	6	Set speaker holder on base
	35	11	Install speaker holder and connect cable to PCB-2
	36	10	Install clock battery on PCB-4
	37	10	Tape down speaker and battery cable
	38	16	Check voltage of clock battery and backup battery
	39	6	Put screws for Opns 44, 46 in foam tray
6	40	13	Install wrist rest over Accupoint buttons
107 sec	41	6	Connect LCD cable to PCB-1
	42	6	Tape cable down
	43	5	Install keyboard support plate to base
	44	23	Screw in support plate
	45	18	Install keyboard, connect cable and set in base
	46	18	Screw in keyboard
	47	8	Install keyboard mask
	48	10	Place cushion pads on LCD mask
7	49	18	Place protective seal on LCD display
108 sec	50	10	Place brand name seal on LCD mask
	51	11	Place brand name seal on outside of cover
	52	8	Connect cable to DVD drive
	53	33	Install DVD on base
	54	22	Install cover on DVD
	55	6	Put screws for Opns 56, 57 in foam tray
8	56	58	Turn over machine and put screws in base
93 sec	57	8	Put in grounding screw
	58	8	Install connector protective flap
	59	8	Install DVD assembly
	60	6	Install battery cover on battery pack
	61	5	Install battery cover
9	62	31	Insert memory card for hardware test and start software
310 sec	63	208	Software load (does not require operator)
	64	71	Test DVD, LCD, keyboard, and pointer; remove memory
10	65	5	Place unit on shock test platform
105 sec	66	75	Perform shock test
	67	10	Scan bar codes
	68	15	Place unit on rack for burn-in

SOURCE: ADAPTED FROM : *TOSHIBA: OME WORKS*, HARVARD BUSINESS SCHOOL (9-696-059).

THE ASSEMBLY LINE

At the head of the assembly line, a computer displayed the daily production schedule, consisting of a list of model types and corresponding lot sizes scheduled to be assembled on the line. The models were simple variations of hard disk size, memory, and battery power. A typical production schedule included seven or eight model types in lot sizes varying from 10 to 100 units. The models were assembled sequentially: All the units of the first model were assembled, followed by all the units of the second, and so on. This computer screen also indicated how far along the assembly line was in completing its daily schedule, which served as a guide for the material handlers who supplied parts to the assembly lines.

The daily schedules were shared with the nearby Fujihashi Parts Collection and Distribution Center. Parts were brought from Fujihashi to the plant within two hours of when they were needed. The material supply system was very tightly coordinated and worked well.

The assembly line consisted of a 14.4-meter conveyor belt that carried the computers, separated at 1.2-meter intervals by white stripes on the belt. Workers stood shoulder to shoulder on one side of the conveyor and worked on the units as they moved by. In addition to 10 assembly workers, a highly skilled worker, called a "supporter," was assigned to each line. The supporter moved along the line, assisting workers who were falling behind and replacing workers who needed to take a break. Supporters also made decisions about what to do when problems were encountered during the assembly process (such as a defective part). The line speed and the number of workers varied from day to day, depending on production demand and the workers' skills and availability. Although the assembly line was designed for 10 workers, the number of workers could vary between 8 and 12.

Exhibit 6A.18 provides details of how the engineers who designed the new subnotebook computer felt that the new line should be organized. These engineers design the line assuming that one notebook is assembled every two minutes by 10 line workers. In words, the following is a brief description of what each operator does:

1. The first operator lays out the major components of a computer between two white lines on the conveyor.
2. The second operator enters the bar codes on those components into a centralized computer system by scanning the bar codes with a hand-held scanning wand. On a shelf above the conveyor, portable computers display the operations that are performed at each station.
3. The next six steps of the assembly process involve a large number of simple operations performed by hand or with simple tools, such as electric screwdrivers. Typical operations involve snapping connectors together or attaching parts with small screws. All tools are hung by a cable above the operators, within easy reach. Although the individual operations are simple, they require manual dexterity and speed.
4. The last two operations are the hardware and shock tests. To prepare for the hardware test, an operator inserts a memory card into the USB port containing software designed to test different components of the computer circuitry. Because it takes nearly four minutes to load the testing software, the cycle time of this operation is longer than the other cycle times on the line. To achieve a lower cycle time for the line, the hardware test is performed in parallel on three different units. The units remain on the moving conveyor, and the tests are staggered so that they can be performed by a single operator. The shock test (the last operation on the assembly line) tests the ability of the computer to withstand vibrations and minor impacts.

The computers are moved to a burn-in area after the assembly-line shock test. Here computers are put in racks for a 24-hour 25°C "burn-in" of the circuit components. After burn-in, the computer is tested again, software is installed, and the finished notebook computer is packaged and placed on pallets.

TWEAKING THE INITIAL ASSEMBLY-LINE DESIGN

From past experience Toshihiro has found that the initial assembly-line design supplied by the engineers often needs to be tweaked. Consider the following questions that Toshihiro is considering:

1. What is the daily capacity of the assembly line designed by the engineers?
2. When it is running at maximum capacity, what is the efficiency of the line?
3. How should the line be redesigned to operate at the target 300 units per day, assuming that no overtime will be used? What is the efficiency of your new design?
4. What other issues might Toshihiro consider when bringing the new assembly line up to speed?

SUPER QUIZ

1. Three terms commonly used to refer to a layout where similar equipment or functions are grouped together.
2. A layout where the work to make an item is arranged in progressive steps and work is moved between the steps at fixed intervals of time.
3. A measure used to evaluate a workcenter layout.
4. This is a way to shorten the cycle time for an assembly line that has a task time that is longer than the desired cycle time. Assume that it is not possible to speed up the task, split the task, use overtime, or redesign the task.
5. This involves scheduling several different models of a product to be produced over a given day or week on the same line in a cyclical fashion.
6. If you wanted to produce 20 percent of one product (A), 50 percent of another (B), and 30 percent of a third product (C) in a cyclic fashion, what schedule would you suggest?
7. A term used to refer to the physical surroundings in which a service takes place and how these surroundings affect customers and employees.
8. A firm is using an assembly line and needs to produce 500 units during an eight-hour day. What is the required cycle time in seconds?