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INTERTop

●Yasuyuki Fukuda

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Interest in mobile information equipment has surged in recent years. This report introduces the INTERTop portable information equipment that was developed to satisfy this demand.
INTERTop is mobile information equipment with open architecture hardware. It includes PIM and an editing function, and is easily portable. Specifically, AT compatible architecture is used with the MS-DOS environment to improve response. The maximum weight is set at 750 g.
This report explains the process of achieving these design targets, the ingenuity employed and future potential of the equipment.

1. Introduction

As personal computers have spread throughout society, more users want to use communication functions from anywhere. This demand has led to the release of various types of mobile information equipment.

Fujitsu has also developed various types of portable information equipment containing a word processor with PC communication software. For example, OASYS Pocket3 features a 640 × 200-dot monochrome reflective LCD and is powered by two AA alkaline dry batteries that last up to eight hours; the OASYS 30AD401/405 features a 640 × 400-dot monochrome half-penetrative LCD and six AA alkaline dry batteries for 20 hours of operation. Meanwhile, the popular ultra-miniature, lightweight FMR Card was developed for notebook personal computers.

However, as use of the Internet continues to spread rapidly, communications have changed from PC-communication-based to Internet-based. INTERTop was, therefore, developed as a portable device with easy-to-use communication functions.

2. Development policy of INTERTop

Figure 1 shows the position of INTERTop in the product categories.

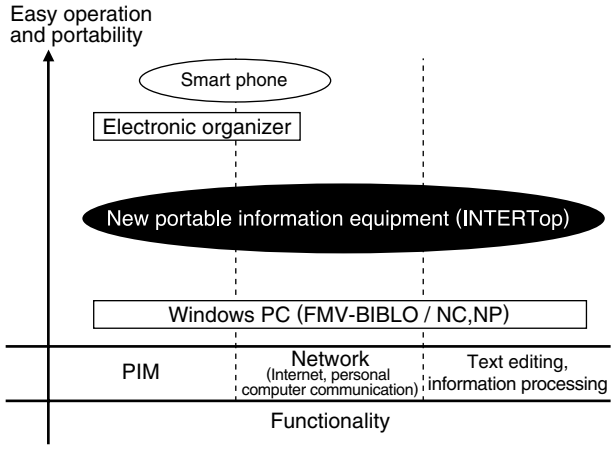

Figure 1.
Product categories.

The vertical axis represents portability while the horizontal axis represents the strength of the three basic functions of portable devices: PIM (personal information manager), network (Internet) communication, and text editor.

For example, products in the lowest part of the figure are personal computers which satisfy all the basic functions and offer full specifications at the expense of portability.

Conversely, smart phones have the same form and size as portable telephones and offer address book and simple scheduling functions, but cannot

be used to edit text. Here, functions are sacrificed for the sake of portability.

INTERTop is positioned for a new market where a product can offer both small size, light weight, and all the necessary functions.

Unlike character-based information for PC communication, both characters and images can be used on the Internet. Therefore, terminals that handle such information need two core functions: a browser to retrieve and display the information, and an Internet mail function.

In addition, PIM is another important function for portable devices to manage personal schedules and address books.

Integrating the functions of Internet communication, PIM and text editing is the critical issue in developing new portable devices. Other important points are as follows:

- Small and light (easy to carry)
- Long battery life (no concerns about batteries during outside use)
- Low price (affordable for individuals)

Comfortable Internet browsing is one of the most important specifications of the product. Due to unsatisfactory results in homepage browsing experiments using a battery-friendly monochrome LCD and a more portable half VGA LCD, we opted for a 640 × 480-dot color penetrative LCD.

3. Target specifications of INTERTop

The following target specifications were set for development of INTERTop based on the above considerations:

1) Architecture

To allow efficient, expandable software development, a worldwide open architecture must be used.

2) Performance

Although a relatively heavy-processing browser for portable equipment and Japanese-processing environments are required, the device must be fast enough not to irritate users.

3) Memory and storage

Memory and storage must be sufficient for the necessary functions as well as providing a user area.

4) Display (LCD)

Since most Internet homepages are color, a 640 × 480-dot 256-color LCD is necessary.

5) Battery

For ecological reasons, rechargeable batteries must be used. The battery life must be at least three hours, or roughly double the average battery life of notebook personal computers (i.e., 1 to 1.5 hours). The batteries must be easily replaceable during operation.

6) PC card

There must be at least one PC card slot to support a PDC (Personal Digital Cellular) card or PHS (Personal Handyphone System) card for mobile communication, and a memory card (e.g., ATA flash card) for external storage.

7) Internal modem

An internal modem operating at least 28.8 kbps is necessary to make browsing viable.

8) Keyboard

A full keyboard is required for sending text such as E-mail. The key-pitch should be as wide as possible within the target machine size; pitch of at least 15 mm is needed for touch-typing.

9) Structure

For portability, the machine should be A5 size and weigh around 700 g, but must also be thin and sturdy enough for mobile use.

10) Others

Touch-panel operation should be available for intuitive use with a pointing device.

4. INTERTop

Table 1 lists the specifications of INTERTop.

To satisfy the design targets, product development involved various considerations and measures.

1) CPU

An AT compatible architecture and MS-DOS were selected. There are already many software tools to enable the efficient development of software for this architecture and operating system.

Table 1.INTERTop specifications.

Item	Specifications
Processor	AMD ELAN SC400 (1-chip PC/AT Compatible CPU)
Storage	Main memory: 4 MB (DRAM) Auxiliary memory: 12 MB (Compact flash card)
Display	Built-in touch-panel, penetrative (with FL backlight) 7.2" color DSTN/640 × 480-dot, maximum 256 colors
Keyboard	Key-pitch 15 mm,Thumb shift/JIS standard keyboard
Pointing device	Film/film touch-panel
Internal modem	Data: maximum 33.6 kbps/Fax: maximum 14.4 kbps
Interface	PC card slot: JEIDA Ver4.2 (PCMCIA 2.1)Type II Standard Compact flash card: Specification Ver1.1 Standard, Infrared ray port: IrDA Ver1.0 (115.2 kbps), RS232: MINI-10-pin
Battery	AC adapter (100 V 50/60 Hz) or lithium ion battery
Battery life Battery charging time	About 2.5 to 3.0 hours (fully-charged and backlight at low brightness) Turned off/Suspend mode: 2.5-3.0 hours, Turned on:6.0-7.0 hours
Dimensions and weight	210 (W) × 149.5 (D) × 29 (H) (mm) (excluding protrusions), about 750 g

Moreover, existing software and various AT compatible elements such as LSI chip-sets can be easily used. To keep pace with the rapidly changing market, Fujitsu should not develop all the software and hardware itself; development should be considered from a global perspective. In line with the choice of AT compatible architecture, the Intel x86 compatible CPU was chosen as the processor of INTERTop.

However, the Intel x86 compatible CPU was still being developed to improve performance for faster processing of various software under MS Windows, with clock speeds increasing every six months. Therefore, the CPU was constructed using a core chip and peripheral chips were selected according to the specifications of each product. Because this chip structure increases the number of signal lines between the CPU and peripheral chips, a larger LSI chip was necessary to provide sufficient terminals for signals (e.g., to control memory, interface with PC cards) to satisfy the INTERTop specifications. More chips were needed because the functions had to be divided.

We requested chip makers to develop a single-chip CPU with the necessary peripheral circuits for AT compatible machines, which should reduce battery consumption and raise CPU performance to about that of the 33 MHz 486SX. We thus decided to use AMDs ELAN SC400 CPU, which offered sufficient performance to meet our specifications, although it was still under development at the time. All basic functions of INTERTop were built into this single-chip CPU.

2) Battery

One goal of INTERTop was long battery life without affecting the browsing function. Conserving power for the entire display unit (including the LCD) was critical to extending battery life. The lithium ion battery used for video cameras was chosen from the outset for its ease of handling and availability.

A color display was vital for INTERTop and a DSTN penetrative LCD was selected to reduce cost. By minimizing the power drawn for the FL pipe backlight of the half-penetrative LCD, average power was kept below 2 watts under ordinary conditions. Because the inverter uses the most power in the backlight unit, an efficient inverter was redesigned using a voltage transformer to decrease power consumption by more than 10% using a rolled wire-wound transformer. Power management was also improved. As a result, battery life

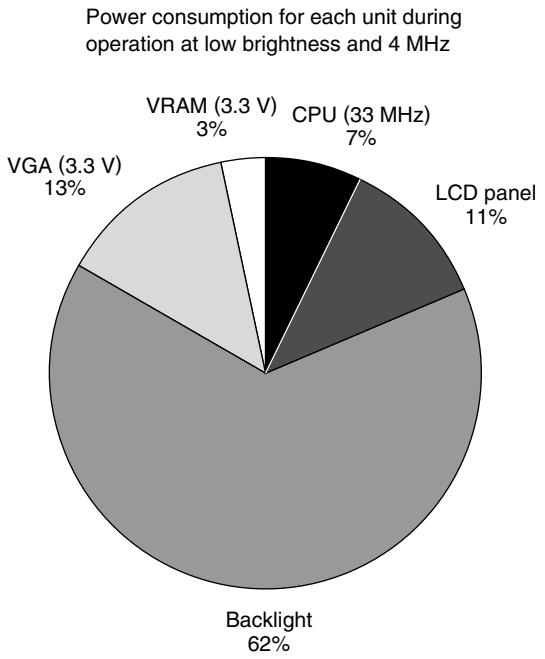

Figure 2.
INTERTop: Power consumption of each unit.

was extended up to three hours (7.2 V, 1,350 mA).

Figure 2 shows the power consumption of each unit of INTERTop.

3) Storage

The CFC (Compact Flash™ Card, 12 MB) was chosen for rewritable storage, as well as an internal ROM drive (6 MB). The card is a memory module that can be used the same way as an IDE hard disk, which is used in many AT compatible machines. Since the card does not have moving parts, it is resistant to vibration and shock (vibration: 15 G, shock: 1,000 G) and is a suitable storage medium for portable devices. Function can easily be upgraded by rewriting the contents of the CFC or replacing the CFC.

4) Internal modem

A new modem module was developed that uses less than about 700 mW of power (compared to conventional modems that need more than 1 W), and achieves a modem speed of 33.6 kbps (i.e., fastest at the time). Even though the modem module is very small (55 × 33 × 5 mm), cost was kept low for a modem designed for general use by using a serial interface to the CPU, and featuring a modular design like that of a stand-alone modem.

(a) Style of common usage

(b) LCD rotated 360°

Figure 3.
Construction of INTERtop.

5) Construction

One of the characteristics of INTERTop is its built-in touch-panel.

To take advantage of two-way input, the LCD part was designed to rotate 360 degrees and be operated without using the keyboard (**Figure 3** and references).

To prevent accidental key input while rotating 360-degrees, a key lock is provided and linked to the tilt function.

6) Touch-panel

Instead of the conventional glass/film type of touch-panel, a film/film touch-panel that is light, thin and strong was developed for the first time in the industry.

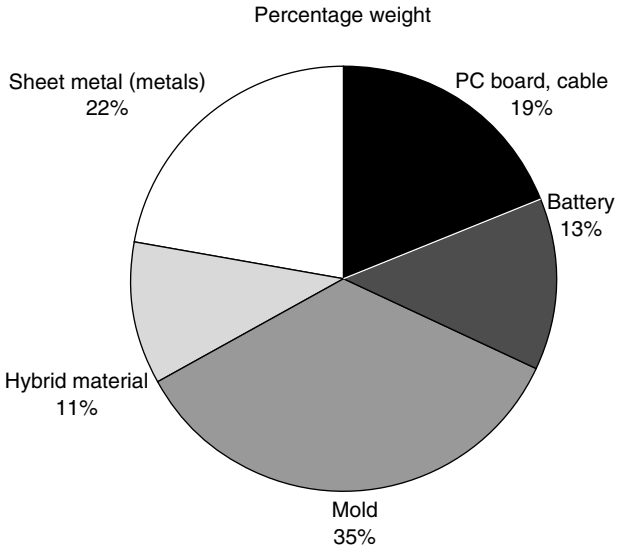

Figure 4.
INTERTop: Percentage weight of each component.

The new touch-panel is half the weight (about 4 g) and thickness (about 0.5 mm) of conventional touch-panels.

7) Weight

The weight of the cover and other components such as the LCD panel was reduced to make the product lighter. **Figure 4** shows the weight of each INTERTop component. To reduce weight, a hybrid magnesium material and lithium polymer battery were initially discussed but later abandoned due to their high cost. INTERTop features an LCD back cover made of Al material (with corrugated processing to improve strength), thin construction with an average mold thickness of 1.5 mm (with some parts only 1.0 mm thick), LCD with glass 0.7-mm thick, and film/film touch-panel. Thanks to these features, INTERTop is the lightest product in the A5-size class at just 750 g (with no increase in cost).

5. Future prospects and conclusion

The mobile computer market is changing dynamically and many new technologies are being developed specifically for this market. New information services are fueling the demand for mobile, wireless computing using portable telephones, while new types of hardware and software (i.e., RISC CPUs, Windows CE) are being developed for portable devices.

New technologies for smaller, lighter and longer battery-life equipment must still address the problems of cost and mass production. We will continue to develop convenient, useful mobile computers for this market, and will utilize the latest technology to solve technical problems.

Yasuyuki Fukuda received the B.E. degree in Electrical Engineering from Science University of Tokyo, Chiba, Japan in 1982. He joined Fujitsu Ltd. in 1982 and has been engaged in development of portable information equipment.