CHAPTER 8

Output And Input Design

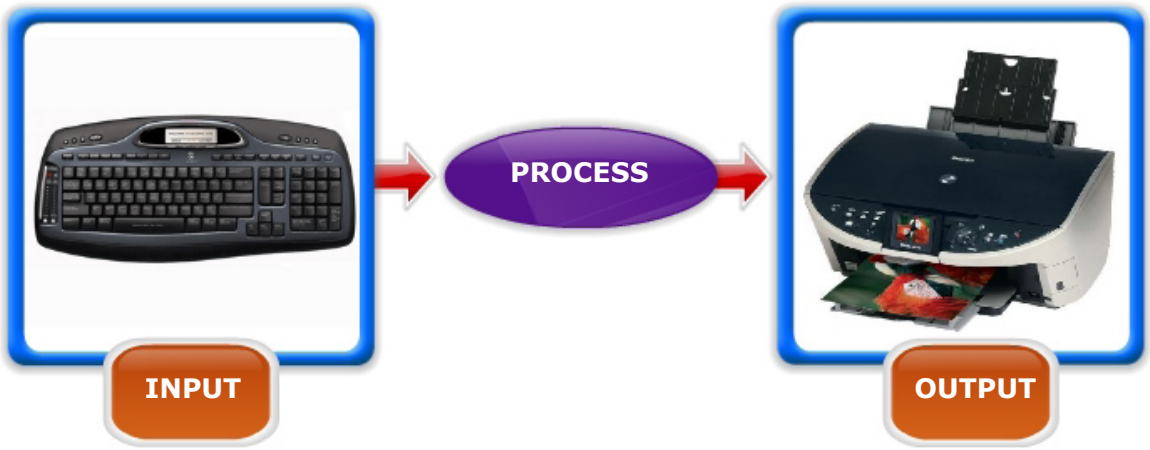
LEARNING OUTCOMES

By the end of this chapter, you should be able to:

1. Describe the objectives for effective output and input design;
2. Realise factors to consider when choosing output and input technology;
3. Describe the difference between printed and screen output;
4. Differentiate data capture, data entry and data processing;
5. Differentiate batch, online and remote processing; and
6. Describe the impact of input volume, input type and input validation.

INTRODUCTION

Systems Design is the third of five phases in the systems development life cycle. Now you are ready to begin the physical design of the system that you and the users have developed a concrete understanding of how the system will operate. Systems design activities include output, and input design, user interface design, data design, and system architecture. In this topic we introduce several fundamentals of output and input design; system architecture will be introduced in the following topic. Data design will be introduced in Database Management module and user interface design will be introduced in Human Computer Interaction module in details.



This topic explains how to design the effective output and input fundamentally. The goal of output design is to ensure the use and acceptance of the system. This can be achieved by understanding output technologies, choosing criteria, printed and screen output. While the goal for input design is to capture accurate information for the system and users. This typically can be achieved by data capture, data entry, data processing, choosing input technologies and input types. It is only when each design activity is consistent with others and satisfactory to the end user that you know that the design phase is successful.

8.1 OUTPUT DESIGN

Output is information delivered to users through the information system by way of intranets, extranets or the World Wide Web. Outputs are the most visible part of any system because a primary reason for using an information system is to access the information that it produces. Output can be in two forms. One is in hard-copy such as printed reports and the other one is in soft-copy which is in the form of computer screens, microforms, audio, web documents and many more. To create output, the analyst works interactively with the user until the output is satisfactory.

8.1.1 Output Design Objectives

Output is essential to ensure the use and acceptance of the information system. The objectives of output design are as follows:

(a) Serve a specific user or organisational purpose. If the output is not functional, it should not be created, because there are costs of time and materials associated with all output from the system.

(b) Meaningful to the user. On the basis of interviews, observations, cost considerations, and prototypes, it is possible to design output that addresses what users need and prefer.

(c) Deliver the appropriate quantity of output. The system must provide what each person needs to complete his or her work.

(d) Make sure the output is where it is needed, to be used and useful, output must be presented to the right user. No matter how well designed reports are, if they are not seen by the pertinent decision makers, they have no value.

(e) Provide output on time. Accurate timing of output can be critical to business operations. Using web-based output can alleviate some problems with the timing of output distributions.

(f) Choosing the right output method. The analyst needs to recognise the tradeoffs involved in choosing an output method. Costs differ for the user; there are also differences in the accessibility, flexibility, durability, distribution, storage, retrieval, transportability and overall impact of the data.

8.1.2 OUTPUT TECHNOLOGIES

Although most system output is printed in reports or displayed on screens, new technology has had an enormous impact on how people communicate and obtain information. For printed output, the options include a variety of printers. For screen output, the options includeattached or stand-alone displays. Audio output can be amplified over a loudspeaker, ranging from small speaker to surround system speaker. Electronic output is created with special software tools. As you can see, the choices are numerous. Table 8.1 is a comparison of output methods.

Table 8.1: Comparison of Output Methods

Output Method	Advantages	Output Method
Printer	• Affordable for most organisations • Flexible in types of output, location,and capabilities • Handles lare volumes of output • Highly reliable with little down time	• Still requires some operator intervention • Compatibility problems with computer software • May require special, expensive supplies • Depending on model, may be slow • Environmentally unfriendly
Display screen	• Interactive Online, real-time transmission • Quiet Takes advantage of computer • capabilities for movement within database and files • Good for frequently accessed, ephemeral message	• May require cablingand setup space • Still may require printed documentation
Audio output and podcast	• Good for individual user • Good for transient messages • Good where worker needs hands free • Good if output needs to be widely distributed	• Is expensive to develop Needs earbuds where output • will not interfere with other tasks • Has limited application

DVD, CD-ROM and CD-RW	• Has large capacity • Allows multimedia output	• Requires a computer for reading data
Electronic output (email, Web sites, blogs, and RSS feeds)	• Reduces paper • Can be updated very easily • Can be "broadcast" • Can be made interactive	• Is not conductive to formatting (email) • Is difficult to convey context of messages (email) • Web sites need diligent maintenance

Source: Adapted from Kendall & Kendal (2008)

List six objectives the analyst pursues in designing system output.

8.1.2 OUTPUT TECHNOLOGIES

There are several factors to consider on choosing output technology. Although the technology changes rapidly, certain usage factors remain fairly constant in relation to technological breakthroughs. Table 8.2 shows an explanation to the factors to be considered:

Table 8.2: Factors to Consider on Choosing Output Technology

Factors	Explanation to the Factors
Who will use the output?	Job requirements help dictate what output is appropriate. Example; when district managers must be away from their desks for a certain period, they need printed output that can travel with them or technology that can access appropriate web sites and databases.
How many people need the output?	If many people need the output, Web-based with a print option or printed copies are probably justified. If only one user needs the output, a screen or audio may be more suitable.
Where is the output needed?	It means the physical destination of the output. Example; an abundance of information that must be transmitted to users at great distances in branch operations may be better distributed electronically via the web or extranets.
What is the purpose of the output?	What user and organisational tasks are supported? Example; if the purpose of the output is to provide 15-minute updates on stock market quotations. Output must support user tasks such as performing analysis, so software tools including calculators and embedded formula could be part of output. It must also support organisational tasks such as tracking, scheduling and monitoring where interactive, real time screens provide useful insights.
What is the speed with which output is needed?	The higher the level of management the faster the output is desired. Example; strategic managers need output for a specific time period, which helps in forecasting business cycles and trends.
How frequently will the output be accessed?	The more frequently the output is accessed, the more important is the capability to view it on the web. Infrequently accesses output that is needed by only a few users are well suited to a CD-ROM archive.
What are the initial and ongoing costs of maintenance and supplies?	The initial cost of purchasing or leasing equipment must be considered as yet another factor that enters into the choice of output technology. The analysts also need to research the costs of operating different output technologies or maintaining a corporate website over time.

8.1.4 Printed and Screen Output

Although many organisations strive to reduce the flow of paper and printed reports, few firms have been able to eliminate printed output totally. Printed outputs are portable and convenient, and even necessary in some situations. However printed output has several significant drawbacks. It is inflexible. Once the report is printed, it cannot be sorted or reformatted to present a different view of the information. Likewise, if the information

on the report changes, the entire report must be reprinted. Printed outputs are expensive, hard to duplicate, and require considerable supplies (paper, ink) and storage space.

Many organisations are therefore moving to electronic production of reports or known as screen output report, whereby reports are "printed," but stored in electronic format on servers so that users can easily access them. Often the reports are available in more predesigned formats than their printed-based counterparts because the cost of producing and storing different formats is minimal. Screen output reports also can be produced on demand as needed, and they enable the user to more easily search for certain words. Furthermore, screen output reports can provide a means to support ad-hoc reports where users customise the contents of the report at the time the report is generated.

While screen output provides the system user with convenient access to information, the information is only temporary. When the information leaves the screen, that information is loss unless it is redisplayed. For this reason, printed output options are usually added to screen output designs. Many users find it handy to view screen output, then print the information they need for a discussion or business meeting.

8.1.5 Reports

Whether printed or viewed on-screen, reports should be attractive and easy to understand. System analysts should realise managers sometimes judge an entire project by the quality of the reports they receive. When designing reports, the essential goal is to match the report to the user's specific information needs. Depending on their job functions, users might need one or more reports as described below.

There are 3 type of reports:

(a) **Detailed report** lists detailed information about all the items requested. They are used for mailing to customers, sending student grade reports, printing catalogs and many more. This report is usually read cover to cover to aid understanding of one or more items in depth.

For example;

Figure 8.1 shows a listing of all purchase orders that were generated on a particular date. Inquiry screens have replaced many detailed reports.

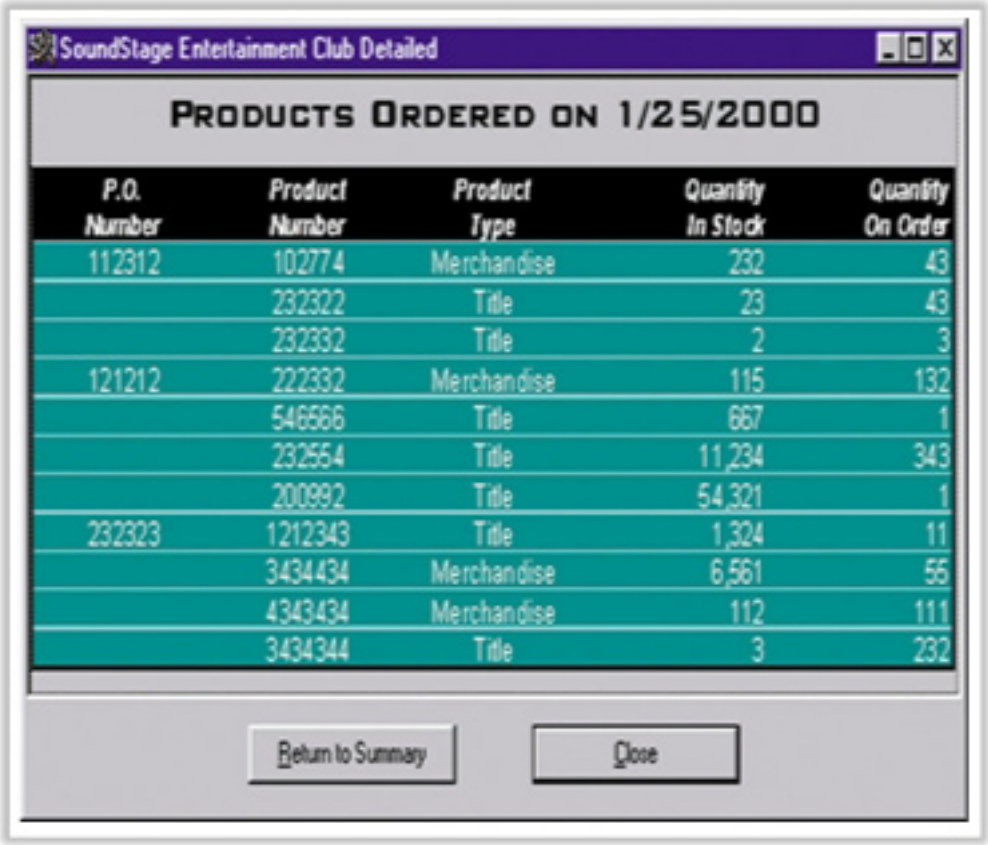


Figure 8.1: Detail report
Source: Adapted from Whitten et al (2004)

(b) **Summary Reports** lists summary information about all items. This report is usually read for the purpose of comparing several items to each other. It categories for managers who do not want to wade through details. Upper-level managers often want to see total figures and do not need supporting details

For example;

Figure 8.2 summarises the months and years total sales by product type and category. The data for summary reports is typically categorised and summarised to indicate trends and potential problems.

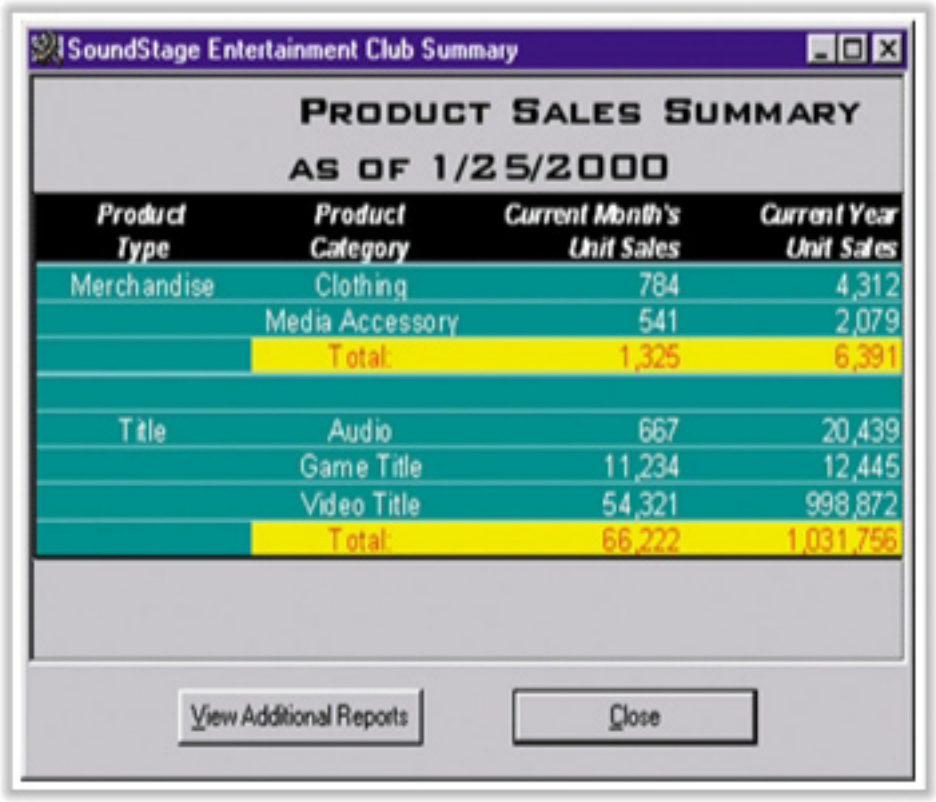


Figure 8.2: Summary report
Source: Adapted from Whitten et al (2004)

(c) **Exception reports** list filtered data for only those records that meet specific conditions. Exception reports are useful when the user wants information only on records that might require action, but does not need to know the details.

For example;

A credit manager might use an exception report to identify only those customers with past due accounts or those employees who worked overtime. Figure 8.3 shows the identification of delinquent member accounts.

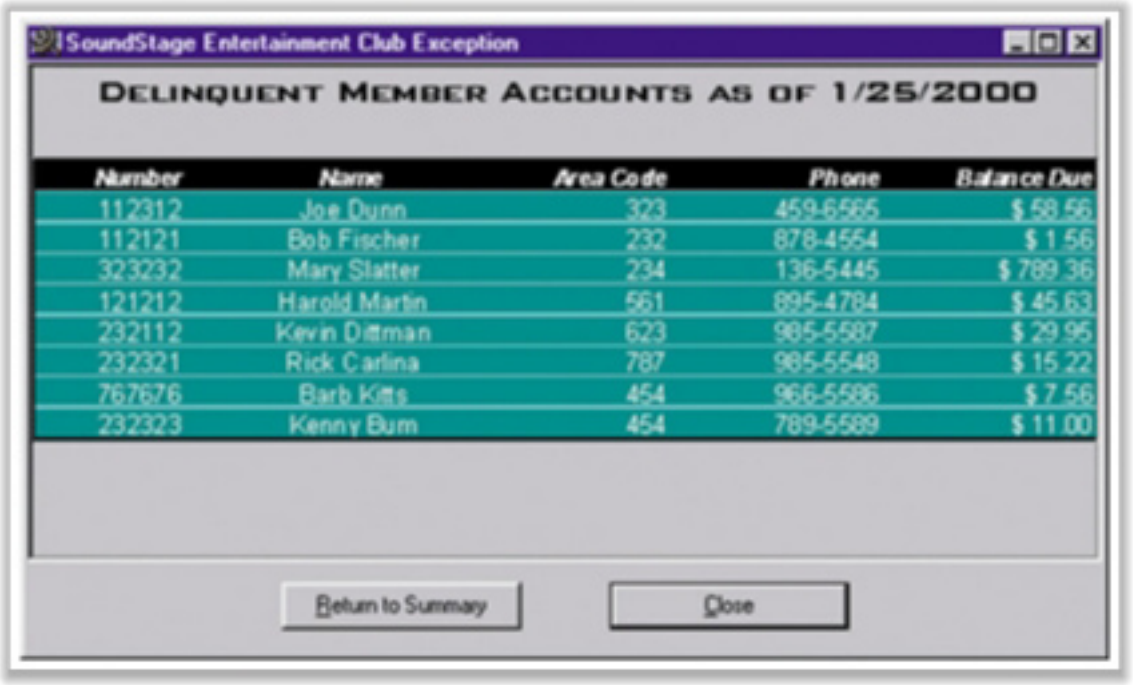


Figure 8.3: Exception report
Source: Adapted from Whitten et al (2004)

Reports are an important way of delivering information to users, so recipients should approve all report designs in advance. To avoid problems, submit each design for approval as you complete it, rather than waiting until you finish all report designs. When designing a report, you should prepare a sample report, which is called a mock-up (or prototype) for users to review. The sample should include typical field values and contain enough records to show all the design features.

Reports can also be presented in graphical formats. Graphic output is the use of pictorial chart to convey information in ways that demonstrate trends and relationships. Well-done charts helps users compare two or more items or understand how one has changed over time. To the system users, a picture can be more valuable than words. Figure 8.4 shows various types of chart that can be output with today's technology.

Chart Type	Selection Criteria
 Line charts	Show one or more series of data over a period of time. They are useful for summarising and showing data at regular intervals. Each line represents one series or category of data.
 Bar charts	Useful for comparing series or categories of data. Each bar represents on series or category of data.
 Column charts	Similar to bar charts except that the bars are vertical. Also, a series of column charts may be used to compare the same categories at different times or time intervals. Each bar represents one series or category of data.
 Pie charts	Show the relationship of parts to a whole. They are useful for summarising percentages of a whole within a single series of data. Each slice represents one item in that series of data.
 Scatter charts	Useful for showing the relationship between two or more series or categories of data measured at uneven intervals of time. Each series is represented by data points using either different colors or bullets.
 Area charts	Similar to line charts except that the focus is on the area under the line. That area is useful for summarising and showing the change in data over time. Each line represents one series or category of data.

Figure 8.4: Sample Chart Types

1. What are three situations that point to printed output as the best choice for output technology?
2. Give two instances that indicate that display output is the best solution for the choice of output technology

8.2 INPUT DESIGN

Input technology has changed dramatically in recent years. Today many input devices and techniques are available. Businesses use the new technology to speed up the input process, reduce costs and capture data in new forms such as the digital signature shown in Figure 8.5. The important goal of input design is to capture accurate information for the users and computer.

Figure 8.5: Digital signatures as input to the system

Input mechanisms facilitate the entry of data into the computer system, whether highly structured data, such as order information (e.g., item numbers, quantities, costs) or unstructured information (e.g., comments). Input design means designing the screens used to enter the information, as well as any forms on which users write or type information (e.g., timecards, expense claims).

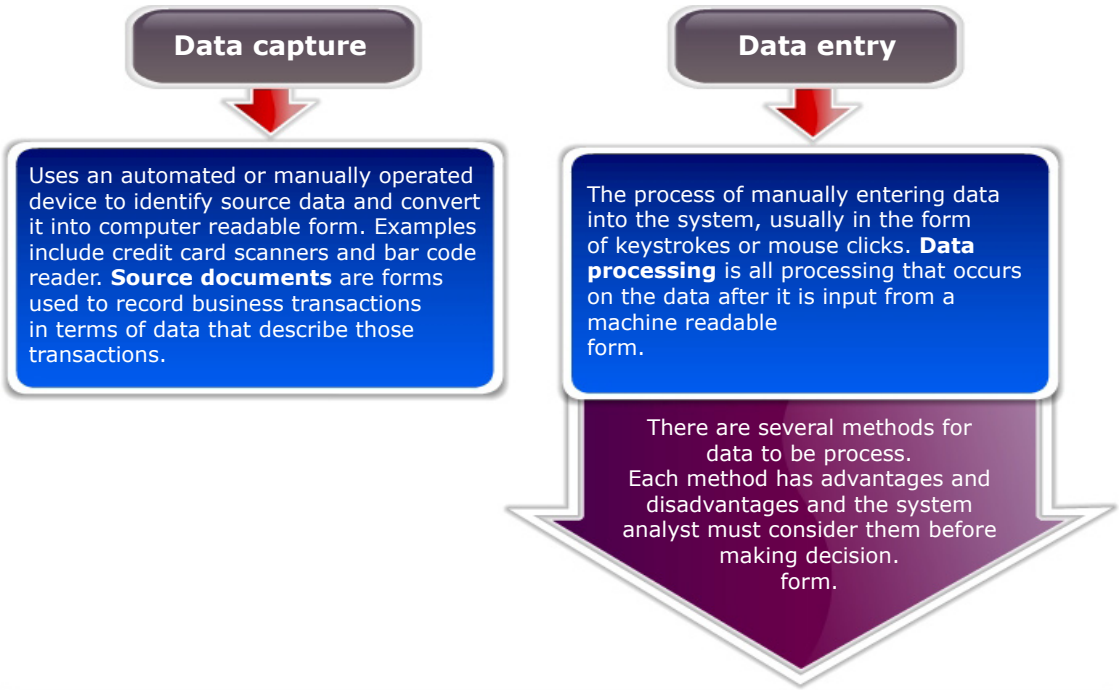
Users deserve quality output. The quality of system input determines the quality of system output. This concept is known as garbage in, garbage out (GIGO). It is vital that input forms, displays and interactive web documents be designed with this critical relationship in mind. Well designed input should meet the objectives of effectiveness, accuracy, ease of use, consistency, simplicity and attractiveness.

Effectiveness means that input forms, input displays and fill-in forms on the web all serve specific purposes for users of the information system, whereas accuracy refers to design that ensures proper completion. Ease of use means that forms and displays are straightforward nd require no extra time for users to understand. Consistency means that all input forms, whether they are input displays or fill-in forms on the web have the same appearance and concept from one application to the next. Simplicity refers to keeping those same designs uncluttered in a manner that focuses the user's attention. Attractiveness implies that users will enjoy using input forms because of their appealing design.

During input design phase, you determine how data will be captured, entered and processed into the system. We will learn in the next section how the data is initially captured, enter the data and finally processed.

8.2.1 Data Capture, Data Entry and Data Processing

What is the difference between data capture and data entry? Figure 8.6 show the differences



Advantages and Disadvantages	Processing Method
Batch processing, the entered data are collected into batches on files and processed in batches by the program. For example a payroll department collects time cards at the end of the week and enters the data as a batch. Another example is a school that enters all grades for the academic term in a batch.	***Batch processing***
Online processing offers major advantages, including the immediate validation and availability of data. A popular online processing method is source data automation which combines online entry data entry and automated data capture using input devices such as radio-frequency identification (RFID) tags or magnetic data strips. This method is fast and accurate and minimises human involvement in the translation process. Examples of source data automation are: • Automatic teller machines that read data strips on bank cards • Point of sales terminals with bar code scanner and magnetic swipe scanners to input credit card data • Libraries that use handheld scanners to read optical strips on books	***Online processing***
In remote batch processing, data is entered and edited on-line, but collected into batches for subsequent processing. A more contemporary example is using handheld devices to collect data for later processing. If you have recently received a package from UPS or Federal Express, you would have seen such devices used by the drivers to record pickups and deliveries.	***Remote batch processing***

Figure 8.6: Data Capture vs. Data Entry

The decision to use **batch** or **online** depends on business requirements. For example, hotel reservations must be entered and processed immediately so that it will reflect the number of rooms available, but hotels can enter their monthly performance figures in batch. There is a tradeoff for each decision made.

8.2.2 Input Technology

Now that we have covered the basic data capture, data entry and data processing techniques, we can examine more closely the input methods shown as rows in Table 8.3. The table shows in particular how the choice of a method affects data capture, entry and processing being implemented.

Table 8.3 Examples of Input Technology

Process Method	Data Capture	Data Entry	Data Processing
Keyboard	Data is usually captured on a business form that becomes the source document for input. Data can be collected real-time.	Data is entered via keyboard. This is the most common input method but also the most prone to errors.	OLD: Data can be collected into batch files (disk) for processing as a batch. NEW: Data is processed as soon as it has been keyed.
Mouse	Same as above.	Used in conjunction with keyboard to simplify data entry. Mouse serves as a pointing device for a screen.	Same as above, but the use of a mouse is most commonly associated with online and real-time processing.
Touch Screen	Same as above.	Data is entered o a touch screen display or handheld device. Data entry users either touch commands and data choices or enter data using handwriting recognition.	On PCs, touch screen choices are processed same as above. On handheld computers, data is sorted on the handheld for later processing as a remote batch.

Magnetic Ink	Same as above.	A magnetic ink reader reads the magnetised data. The customer-added data must be entered using another input method.	Data is almost always processed as a batch.
Electromagnetic	Data is recorded directly on the object to be described by data.	Data is transmitted by radio frequency.	Data is almost always processed immediately.
Smart Card	Data is recorded directly on a device to be carried by the customer, employee, or other individual that is described by that data.	Data is read by smart card readers see Figure 8.6	Data is almost always processed immediately.
Biometric	Unique human characteristics become data	Data read by biometric sensors. Primary applications are security and medical monitoring	Data is processed immediately.

Examples of input devices as shown in Figure 8.7.

Figure 8.7 Example of input devices; Handheld Computer and Smart Card Reader

8.2.3 Input volume

To reduce input volume, you must reduce the number of data items required for each transaction. Data capture, entry and processing require time and effort. In other words, when you reduce input volume, you can avoid unnecessary labor cost, get data into the system more quickly and decrease the number of errors. The following guidelines will help reduce input volume:

(a) Input necessary data only. For example a completed order form, might contain the name of the clerk who took the order. If that data is not needed by the system, the user should not enter it.

(b) Do not input data that the user can retrieve from system files or calculate from other data. In the order system example shown in Figure 8.8, the system generates an order number and logs the current date and time. Then the user enters a customer ID. If the entry is valid, the system displays the customer name, so that the user can verify it. The user then enters the item and quantity. Note that the description, price, sales tax and grand total are retrieved automatically or calculated by the system.

(c) Do not input constant data. If orders are in batches with the same date, then a user should enter the order date only once for the first order in the batch. If orders are entered online, then the user can retrieve the order date automatically using the current system date.

(d) Use codes. Codes are shorter than the data they represent and coded input can reduce data entry time. For example in Figure 8.8, the Customer ID and Item fields are codes.

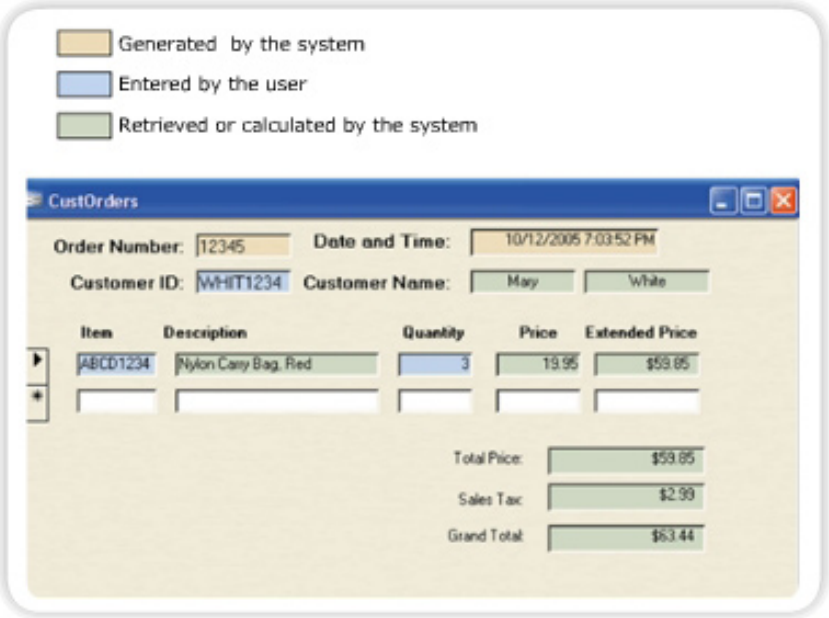


Figure 8.8: Example of order system

8.2.3 Input volume

This section explains some of the most common control used in the input forms. There are many different types of input and Figure 8.9 illustrates the most commonly used.

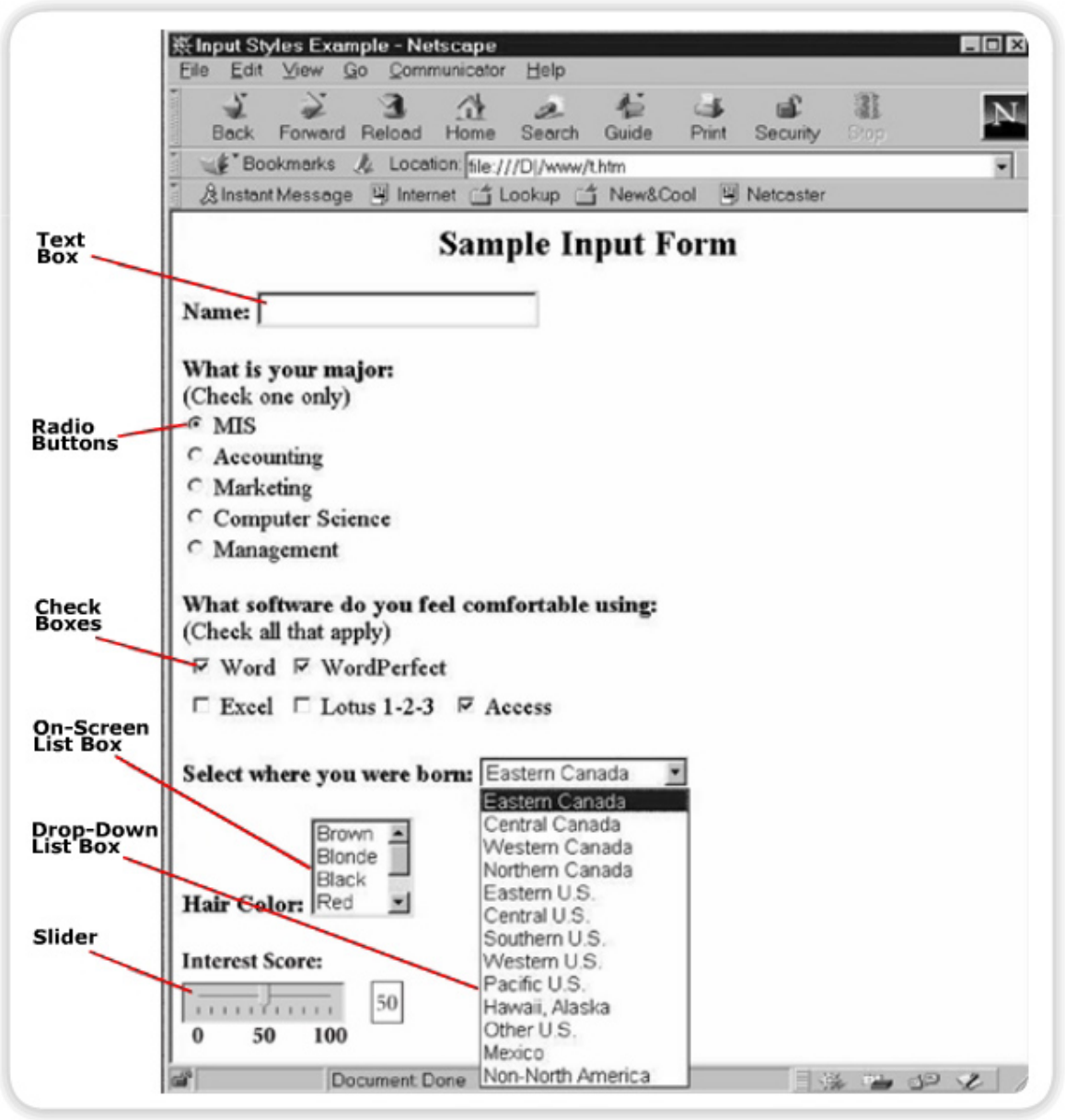
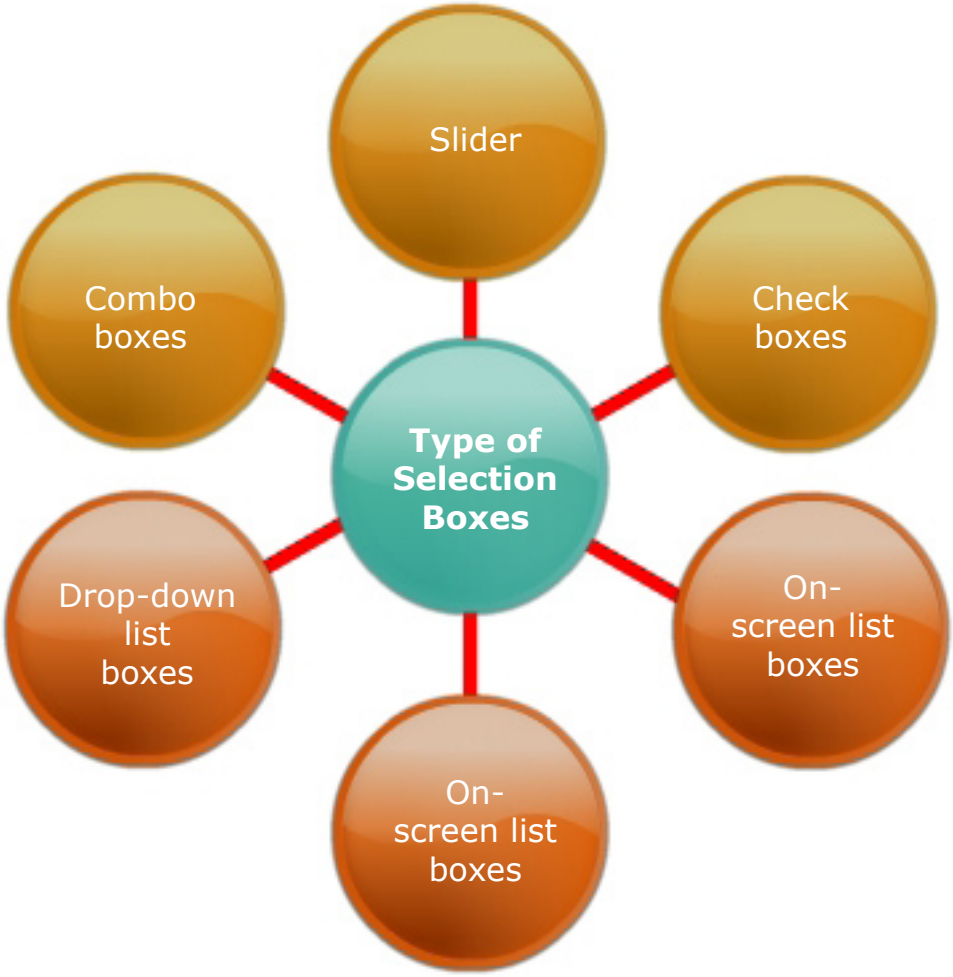


Figure 8.9: Types of Input

Text Boxes are used to outline data entry and display fields. It can be defined to have a fixed length or can be scrollable and can accept a virtually unlimited amount of text. In either case, boxes can contain single or multiple lines of textual information.

Selection Box A selection box enables the user to select a value from a predefined list. The items in the list should be arranged in some meaningful order, such as alphabetical order for long lists, or in order of most frequently used. The default selection value should be chosen with care. A selection box can be initialised as "unselected." However, it is better to start with the most commonly used item already selected.

There are six commonly used types of selection boxes as shown in Table 8.4.;



The choice among the types of text selection boxes generally comes down to one of screen space and the number of choices the user can select. If screen space is limited and only one item can be selected, then a drop-down list box is the best choice, because not all list items need to be displayed on the screen. If screen space is limited but the user can select multiple items, an on-screen list box that displays only a few items can be used. Check boxes (for multiple selections) and radio buttons (for single selections) both require all list items to be displayed at all times, thus requiring more screen space, but since they display all choices, they are often simpler for novice users.

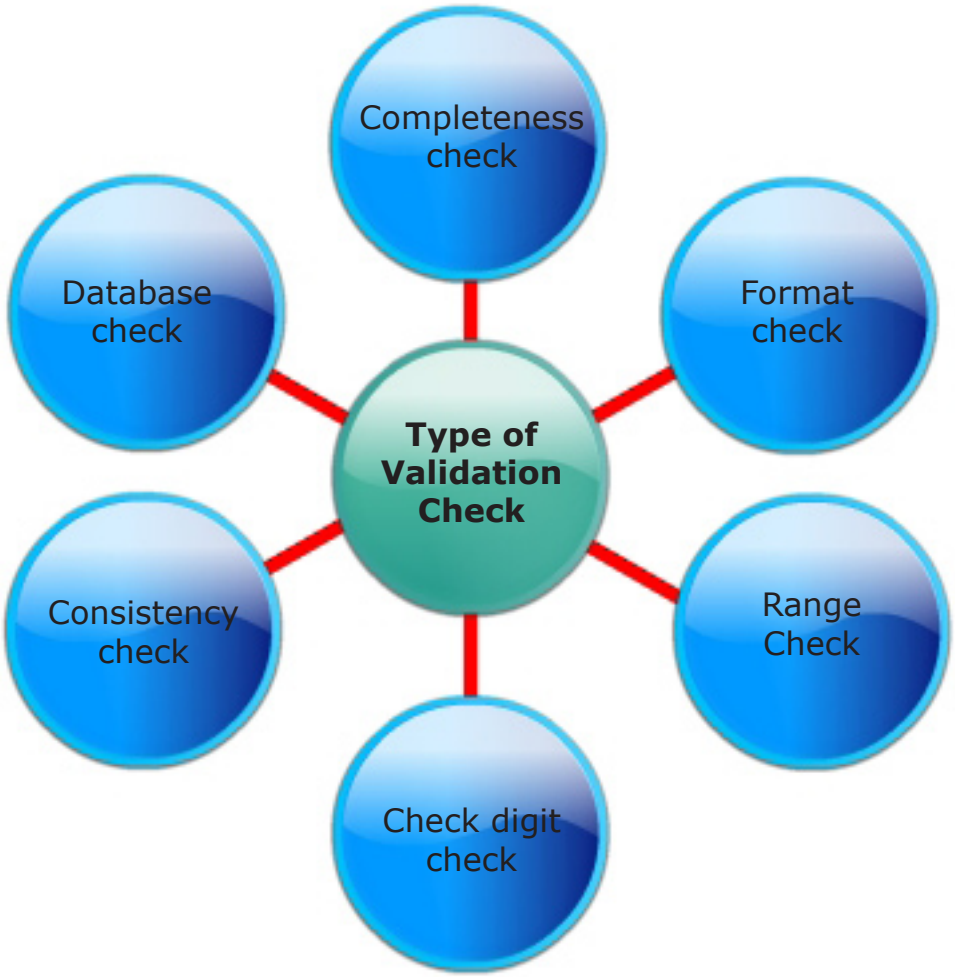
Table 8.4: Types of Selection Boxes

Type of box	When to use	Notes
Check box - Presents a complete list of choices, each with a square box in front	When several items can be selected from a list of items	Check boxes are not mutually exclusive. Check box labels should be placed in some logical order, such as that defined by the business process, or failing that, alphabetically or most commonly used first. Use no more than ten check boxes for any particular set of options. If you need more boxes, group them into subcategories.
Radio button - Presents a complete list of mutually exclusive choices, each with a circle in front	When only one item can be selected from a set of mutually exclusive items	Use no more than six radio buttons in any one list. If you need more, use a drop-down list box. If there are only two options, one check box is usually preferred to two radio buttons, unless the options are not clear. Avoid placing radio buttons close to check boxes to prevent confusion between different selection lists.
On-screen list box - Presents a list of choices in a box	Seldom or never used, only if there is insufficient room for check boxes or radio buttons	This type of box can permit only one item or multiple items to be selected This type of box permits the list of items to be scrolled, thus reducing the amount of screen space needed.
Drop-down list box - Displays selected item in one-line box that opens to reveal list of choices	When there is insufficient room to display all choices	This type of box acts like radio buttons but is more compact. This type of box hides choices from users until it is opened, which can decrease ease of use; conversely, because it shelters novice users from seldom-used choices, it can improve ease of use. This type of box simplifies design if the number of choices is unclear, because it takes only one line when closed.
Slider - Graphic scale with a sliding pointer to select a number	Entering an approximate numeric value from a large continuous scale	The slider makes it difficult for the user to select a precise number. Some sliders also include a text box to enable the user to enter a specific number.

8.2.5 Input Validation

All data entered into the system need to be validated to ensure their accuracy. Input validation is also known as edit checks and can take many forms. Ideally, computer systems should not accept data that fail any important validation check to prevent invalid information from entering the system. However, this can be very difficult, and invalid data often slip by data entry operators and the users providing the information. It is up to the system to identify invalid data and either make changes or notify someone who can resolve the information problem.

There are six different types of validation checks as shown in Table 8.5:



NOTES

Every system should use at least one validation check on all entered data, and ideally will perform all appropriate checks where possible.

Table 8.5 shows the description of input validation type.

Table 8.5: Input Validation Types

Type of Validation	When to use	Notes
Completeness check - ensures all required data have been entered	When several fields must be entered before the form can be processed	If required information is missing, the form is returned to the user unprocessed.
Format check - ensures data are of the right type (e.g., numeric) and in the right format (e.g., month, day, year)	When fields are numeric or contain coded data	Ideally, numeric fields should not permit users to type text data, but if this is not possible, the entered data must be checked to ensure it is numeric. Some fields use special codes or formats (e.g., license plates with three letters and three numbers) that must be checked.
Range check - ensures numeric data are within correct minimum and maximum values	With all numeric data, if possible	A range check permits only numbers between correct values. Such a system can also be used to screen data for "reasonableness" e.g. rejecting birthdates prior to 1880 because people do not live to be a great deal over 100 years old (most likely, 1980 was intended).
Range check - ensures numeric data are within correct minimum and maximum values	With all numeric data, if possible	A range check permits only numbers between correct values. Such a system can also be used to screen data for "reasonableness" e.g. rejecting birthdates prior to 1880 because people do not live to be a great deal over 100 years old (most likely, 1980 was intended).
Consistency checks - ensure combinations of data are valid	When data are related	Data fields are often related. For example, someone's birth year should pre-cede the year in which he or she was married. Although it is impossible for the system to know which data are incorrect, it can report the error to the user for correction.

Database checks - compare data against a database (or file) to ensure they are correct	When data are available to be checked	Data are compared against information in a database (or file) to ensure that they are correct. For example, before an identification number is accepted, the database is queried to ensure that the number is valid. Because database checks are more "expensive" than the other types of checks (they require the system to do more work), most systems perform the other checks first and perform database checks only after the data have passed the previous checks.

Why is input validation important?

SUMMARY

- This topic began with a discussion of output design objectives and various types of output technologies such as printer, audio, display screen and electronic output. You learned about various types of printed reports including detail, exception and summary reports. Factors to consider choosing an output technology were explained for better output design and decision making.
- Input design includes both the design of input screens and all preprinted forms that are used to collect data before it is entered into the information system. There are many types of inputs, such as text boxes, check boxes, radio buttons, on-screen list boxes, drop-down list boxes sliders and many more. During input design, you learned about data capture, data entry and data processing with methods for data to be process such as batch, on-line and remote processing. Finally input design includes selecting appropriate input technology and input types, while maintaining input validation and reducing input volume.

KEY TERMS

Batch processing

Data capture

Data entry

Data processing

Detailed report

Exception reports

Garbage in, garbage out (GIGO)

Graphic output

Graphical user interface design (GUI)

Graphic output

Online processing

Remote batch processing

Source documents

Summary reports

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