Information systems design:  
a procedural approach

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Abstract

The procedure of Information Systems (ISs) design aims to assist in the  
discovery of that solution which shall both cover in the best possible way the  
users' demands and also be feasible within the framework of the data processing  
environment of the corporation.  
In general, a good ISs design should possess the following characteristics: to  
be acceptable by all users, to be auditable, to be functional, to face problems  
"head on", to be satisfactory, not to be costly, to be easy in its development-  
maintenance and operation, to be will documented, to be easily evaluated.  
It is believed that the above presuppositions are covered, to a great extend, by  
the proposed procedure.  
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operationability.

1 General comments, purpose

It is important for the ISs design to start with an itemization of all the necessary  
steps which will be taken for its implementation (initial outline design), because  
this will ensure a large probability for the design to be both correct and  
satisfactory.  
The itemization of these steps- i.e. the outline, or scenario design-must be based  
upon:  
- the grouping of the new system's requirements,  
- the detection of the necessary presuppositions,  
- the classification of cases into categories:  
  • required (must...)
• desirable (should…)
• welcome (could…)
- the consideration of the effect upon the input/processing/output as well as upon the method and the working procedures of users.

The sooner the initial outline design commences, the greater the probability of achieving:
- the (final) selection of the main issues and goals of the system before the accumulation of the main volume of information, the "study" of which shall cover all "available" time,
- the examination, of the already defined requirements of the new system, prior to the design job, which is time-consuming.
- the users' instruction on the effects of the system upon their work procedures and methods.

The consideration of all the above shall be of help in "ensuring" that the user requirements have been correctly defined before proceeding with the "detailed" design of the system.

The purpose of the Design phase is the recording of the specifications, which shall enable the full and exact system implementation without the need for further user help in providing supplementary information during its development.

This does not mean that during the implementation phase contact with users is cut off, since "implementation" does signify more than the realization of the system's programs.

Finally, the "basic" design of the new information system should have a "top-down approach, i.e. start with the "larger issues" and head to the "smaller" ones (top-down approach).

2 Systems design

The Design phase of IS's Development is usually split in two distinct stages; the stage of External or Logical Design and the stage of Internal or Physical Design.

2.1 External Design

The goal of the External Design is the detailed specification of the necessary actions and procedures, as well as the data needed for the implementation of the business process.

Out of these procedures, it is necessary to determine which ones will be finally performed by the computer, and, therefore, which data should be "kept" in Data Bases and/or Traditional Data Files.

Some of the activities of this phase involve a more detailed "re-examination" of the output of the systems requirements definition. As a result, possible errors or omissions should be corrected/amended and approved before the main systems design.

The principal output of the External Design consists of:
The definition of new procedures, as previously stated.
The definition of file records and messages. In particular, the definition of:
input documents and input screens,
the status of output lists and screens,
the contents of file records,
"internal" messages of the system, and
"dialogues".
- The outline definition of databases.
- Data descriptions, which, at this stage, should cover:
  the field name,
  its size (number of characters)
  a brief description of its purpose, and its possible significance within the
  business process,
  the values (decoding) and their meaning in case the field is a code,
  the indication (cross-reference) of the files and messages in which the record
  appears, and
  the method of the creation of a record, of it is the result of processing of
  other records.

The definition of the business factors, upon which the decision-making
process is based. Such factors, may be quantities, discount limits etc. and should
be "itemised" and defined independently of The programs which shall make use
of them.
- The outline definition of the various systems procedures.
- The authoring of the Users' Manual. This should comprise:
  • a general report on the purpose of the system,
  • its description,
  • system operating instructions,
  • the design of input forms, the design of output reports,
  • the description of message to and from the computer, and
  • the design of screen formats.

2.2 Internal Design

The goal of the Internal Design is the exact definition of the manner of
implementation of the procedures "designed" in the previous phase of external
design. The output of Internal Design should comprise:
- The System Flow Chart Design, which should be detailed for batch systems.
- The Specifications of System Transactions.
- The Program's Specifications.
- The Physical Data Base Design and Definition.
- The realization of the Systems Test Plan.
- The realization of Systems Test Data.

3 Information systems design procedure

3.1 Introduction

Any Information Systems Design Procedure should describe in detail the
necessary tasks for its implementation, locate the most important design criteria
of each task and suggest a method of breaking down the various requirements, so as to facilitate both the work and its evaluation.

In practice, a design procedure is "iterative", as one is forced (due to new data, resulting mostly from users' omissions) to return to already completed tasks, in order to enhance or correct them. This "iteration" is continued until the users' final requirements of the new system are fully met.

Subsequently, The Flow Chart of such a Procedure is presented, and immediately following, its sixteen steps are described. Adhered to it, one can be assured of a proper System Design.

Figure 1: Flow of the steps (B1 - B16) of an information design system.
3.2 Description of the steps (B1-B16) of Information Systems Design

B1 Determination of the most important output data
While planning the systems output, its goal should be determined, the user requirements should be defined and its content should be described.
Determination of the goal

The specific goal of the output should be exactly defined. Using the "verb-noun approach" (Top-Down Analysis) one can be offered of significant help. For instance:
Authorize (Action),
Confirm (Accuracy),
Notify (Situation),
Report (Progress),
Order (Action),
Register (List),
etc.

All the above are indicative and the parentheses should include as many descriptive words as possible.

Following, whatever is necessary to support the basic goal of the output, should be studied. That means:
what kind of actions are expected (by the users) with the output delivery,
what kind of commands are required, and
what kind of information is needed.

Determination of the user requirements

At this stage, the perception about the output has to be "cleared out", taking into consideration two possible aspects, from the users' point of view:
- the probability that the output will cause the receiver a favorable situation, and
- the receiver's possibility to respond accordingly to the requirements.

This, of course, demands that the following possible levels of the receivers have been considered:
- intelligence,
- education,
- training, and
- experience.

Definition of the content

Following the above mentioned, the informative data can be defined, i.e. the data which are required for the "formation" of the output. This effort should terminate in the naming of the data groups and probably in the fields which will be included in these groups.

These three stages, (determination of the most important output data, determination of the user requirements, definition of the content) are required for the procedure of the whole systems design but they are inadequate for the whole design of the output data. That is why they should be "completed" with the work for:
- a unified format
- the creation of a distribution plan, and
- the evaluation in case of any restrictions.
**B2 Determination of the necessary input data**

The amount of the required data for the system's input might be bigger than the one for the output. The effort for this determination can be significantly assisted, if the classification is as follows:

- identification data,
- descriptive data,
- measurement data,

The first ones are the "means" to find a specific item, that is, the key, such as, the number of the material, in case the item is a kind of material.

The second ones explain the item and in that way they "confirm" the identity.

The third ones quantify the items and the transactions' results.

This classification is a small part of the Data Analysis Procedure and helps in the decision of which data:

- should be stored
- will be simply used by the system
- will be used by a specific process of the system.

**B3 Determination of the necessary processing for the transformation of the input data to the required output data**

During this step, the "processing" has to be defined, that is, the functions which will have to be performed for the conversion of the input data into the required information output.

Probable functions are:

- calculations,
- classifications,
- sorting,
- summarizing and
- reproducing.

Apart from these functions, the following should be defined as well:

- capturing,
- verifying,
- storing,
- retrieving,

but these will be explained during the next steps of the procedure.

**B4 Determination of the requirements of data processing control**

It is well known that there exist declinations between the desired situations and those which occur mainly during the initial stages of an informative system.

Therefore, the probability of these declinations should be restricted and at the same time they should be located and restored whenever they occur.

Thus, at this step, those controls will be defined which are needed for the confirmation of accuracy and validity of the processing functions.

This is the reason why the usage of programmed (through computer programs) controls has to be studied, such as:

- limit control,
- numerical evidence,
- identification,
B7 Determination of which data the input shall consist of in each process (e.g. orders, incoming stock, e.t.c.) as well as which data shall be set in storage for future use

Practically the procedure of data analysis will have to be done before any design procedure starts.

At this step, the following should be confirmed:
- definition,
- classification,
- selection and
- coding
of the data which have to be "stored".

Therefore, the decision to be taken on which data should be 'stored', will be assisted by taking into consideration the following:
- quantity/time,
- quality and
- cost.

Quantity/Time

Certainly, data cannot be "stored" infinitely in a data base, therefore, a selection is required.

Through the quantity/time inspection the following ways can be studied:
- acquisition,
- retrieval, and
- data retention.

Acquisition
This will influence and will be influenced by the method of data capture (BII). At this stage the time of data collections, enlistment and coding has to be known.

Retrieval
This is referred to the way and the time of data "retrieval" from the data base for the creation of the information output.

Retention
This is referred to the period during which the data must be kept in the data base.

Quality

There are some very significant factors which will have to be studied during the selection of the data to be stored, such as:
- validity,
- accuracy
of the data, to such an extent that they ensure the confidence about the information output.
Validity

This is referred to the data's "ability" to create the information output, which will solve a problem or make a decision.

Accuracy

It is known that the data collection costs and that any decrease of their quantity contributes to the decrease of the cost which is required in order to collect and diminish the number of errors to be listed. The accuracy of the data depends on the way they are collected as well as the frequency they are updated.

Cost

The data storage, in the way that the computer operation demands for a quick and effective approach, costs too high.

One of the factors that affect the decision for such a storage is the necessity to use the existing storing possibilities in the most effective way.

B8 – B13 Data base design

Generally, for the data base design, there are two logically divided goals:
- The design of a data structure, which can approach its real structure, as practically as possible.
  This design is defined mainly by the following actions: » entity analysis, « data modelling,
  * determination of the files update requirements, (Step 8),
  * determination of the data retrieval requirements (Step 9), and
  * determination of the means of data storage and the DB Structure (Step 10).
- The design of effective ways of collecting data and their location in the data base, as far as the cost is concerned. This design is done in 3 stages (B11, B12, B13). Nevertheless it may occur that an action during one of these steps limits or cancels part or all the work of other steps.

B11 Data capture

At this step, the method of "capturing" the data, the moment they are created, has to be decided. Therefore, the following two factors should be considered: the kind of input that is required for the work to be done and the kind of controls which are necessary to ensure the correct operation of the system.

B12 Data transmission

The requirements for the data transmission can be studied during other working phases, such as, the decision phase for the processing through remote terminals. Of course, if this has not been done yet, it should be, during this step.

B13 Data entry

The input procedure of the data in the computer, must be examined, and mainly for the following cases:
- the direct entry procedure to the computer (mainly by the users), and
- the "off line storage", mainly by the data entry operators for a further processing.
B14 Systems security and control

The system has already been designed, and although it is on a general base, it is "capable" of creating the required information output. At this step it should be confirmed that the system:
- is capable of resisting to pressures which could hinder the production of its results to the desired levels, and that
- during its operation, it will not cause any problems to the operation of other systems.

Also, at this step, the systems integrity should be confirmed, by inquiring into:
- the cases of possible errors,
- the following actions for their corrections, and
- the cases of "securing" the system from any possible malevolent actions.

Consequently, during this step, it is necessary for all the cases which have not been faced yet to be added to the design up to the point of:
- the system control and the error detection/correction, as well as
- the system's security operations, which will isolate its delicate points and which will permit the access to authorized people only.

B15 Review of the design for the facility of its implementation

The last step on the procedure of the design is the confirmation that the system covers all the presuppositions for an easy realization and implementation, that is, Programs, Installation, Operation.

This will require the full understanding of:
- the system's goals and activities,
- the administration of the means to be used,
- the system's quality controls,
- the time schedules which will have to be kept,
- the training which will be required for the operation of the system, and
- the requirements of the system's physical installation.

B16 Walkthrough/inspect the design

At this step, one of the following two typical techniques can be used:
- walkthrough or
- inspection

for the confirmation of the design's accuracy and quality, in the way that it has been realized up to that point of the system's development.

Walkthrough

During a walkthrough the analyst describes the operation of some parts of the designed system to 2-3 other colleagues and to one analyst and a programmer of the project team. This description is done by the usage of sample data and the simulation of the system's operations. That means that it is done by a dry run of the system.
The aim of the walkthrough is to be proved that the system really covers the requirements for which it is developed. Any differentiation from the development and installation standards have to be noticed, but the effort should be directed mainly to the error discovery. It is obvious that the error correction will be left to the analyst for the time after the Walkthrough, otherwise, the walkthrough will never end.

Inspection

This differs from the walkthrough mainly because of the presence of a Judge who operates as an independent coordinator of the inspection. The design is described in the inspection as well, but by a member of the team, who has not contributed to it. In case of the opposite situation, the inspection does not differ significantly from the walkthrough.

Comparison between walkthrough and inspection

Generally an inspection is more formal than a walkthrough and has less chances to be degenerated to a comedy.

It is sure that the inspections are more effective in the error detection; they require though a better training and preparation and probably they do not fit to small Data Processing Centres.

4 Epilogue

It is better for the accuracy and the wholeness of the design to be checked continuously while it is being built, than to leave this control to the formal Walkthrough and Inspections.

A series of questions that will be referred to the requirements of every step of the design procedure, will be helpful for the confirmation that the design has been realized correctly.

For every part of the design, questions which begin as the following could be used: What? Why? Who? Where? When? How? in order to confirm that the system's basic requirements have been satisfied.

The above procedure can be expanded in more details, through the evaluation of each part of the design, in relation to its: operation, its goal, performance, reliability, maintainability, flexibility, facility of implementation, facility to confirm its validation, requirements as far as the staff's training is concerned, etc.

Since every part of the design, immediately after its realization has been judged satisfactory under the above criteria, it is almost sure that the new IS will have been designed correctly.

References
