

CASE TOOLS IN AN IRM ENVIRONMENT

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VÄGVERKET (Swedish National Road Administration, SNRA) is a decentralized organization with a number of regional units sharing many similarities. EDP support shall enable an efficient information supply throughout the entire organization through widespread usage of common data. Data includes both data structurable in tables as well as different documents. Data is considered to be an integrated corporate resource requiring administration. IRM (Information Resource Management) in SNRA's decentralized organization is achieved by a corporate data policy, issued by the Director General, and completed by a set of steering instruments. The steering instruments are:

- * common structures (for data, business functions, hardware, data storage, applications)
- * standard methods (for modelling, security, system development)
- * standards for hardware and general software
- * information administration functions on different levels.

One of the standards for general software is the so-called System Development System (SDS), an integrated EDP tool for system developers. SDS supports also the initial stages of system development and the methods used in them. This means that SDS must include CASE tools. CASE tools in an IRM environment means that CASE tools are not longer exclusive tools for professional system developers. CASE tools are used for description of all types of structures related to information handling. It means data structures, business functions structures, EDP equipment structure and program system structure (data storages and applications).

The structure descriptions are needed by user groups which are not EDP professionals. Information administrators use them for description of information effects of business planning, system administrators use them for different tasks in system administration (maintenance, planning, user support), and, last but not least, end users use them for information retrieval. Integration of information handling into business operations means that in the future we can also expect direct usage of these structure descriptions in all kinds of business development.

We have identified three essential demands regarding integration:

- * integration between different types of structures
- * integration between CASE and other development tools
- * integration between CASE and applications in operation.

We have also identified three levels of functionality of CASE tools:

- * documentation
- * documentation + retrieval
- * documentation + retrieval + different controls.

Today, we meet the common conflict between vast expectations on CASE tools and their modest functionality. Nevertheless, we will start now with simple CASE tools, but use them in a flexible way. The further development will take us closer to our vision. During the time, we expect to be forced to move our structures between different tools several times.

Keywords: CASE, IRM, Information Administration, System Administration, System Development, Information Retrieval, Modelling, Data Dictionary

1. The Swedish National Road Administration (SNRA)

Approximately 13,000 people work for the SNRA; of these, about 8,500 are employees. The 1988 budget was 8 milliard SEK. The SNRA administers approximately 100,000 kilometres of national roads and supervises the distribution of state grants to both major municipal as well as private roads.

Head Office with its approximate 650 employees is situated in Borlänge. In addition to the top management, six service departments with most of the specialists and research and development personnel are located there. The regional organization consists of a road administration in every county with an average of 60 employees. On the local level there are approximately 250 maintenance and operation areas with about 15 employees working at each. On the construction side, the SNRA is organized into six construction districts each with approximately 30 regionally employed people. A hundred or so construction work sites consisting of a varying number of employees come under the supervision of these construction districts.

The EDP department with a little more than 100 employees is one of the six departments situated in Borlänge. It prepares policies for EDP support on top management request as well as provides EDP support to the entire organization. It also supplies computer utilities for the Head Office as well as personnel for EDP development. These two latter services are debited internally.

2. EDP within the SNRA

Until recently, EDP support within the SNRA was totally based on Unisys computers used in different types of applications. The most important of these were: finance administration, personnel administration, information on roads and traffic, as well as EDP support for road design. At the regional level, there were approximately 50 terminals and 250 personal CP/M computers used both as terminals and as independent computers for less complicated applications. EDP support was, in practice, totally absent at the local level. On the whole, it could be said that EDP was used extensively; i.e., as isolated systems supporting certain operations in the central administration, and, to a lesser degree at the regional level.

The first stage of the new generation SNRA computerization program was accomplished in 1987-8 at a cost of more than 400 million SEK. This stage provided standardized and integrated computer utilities. VAX computers were installed at the Head Office as well as at every Regional Road Administration. More than 2,000 terminals and personal computers were connected to these at the central, regional and local level. The total equipment cost was approximately 200 million SEK. Office automation programs were installed as well as 8 different applications covering the basic needs of the most important user categories at the SNRA. The applications were developed within the SNRA at a total cost of over 100 million SEK. 3,000 users have been trained at a cost of 100 million SEK.

3. SNRA Policy for Information Management

EDP within the SNRA is administered through a general overall policy for the entire organization. This policy states the strategic goals for EDP support, the steering prerequisites as well as the strategy to be used.

The strategic goals can be expressed as an overall efficient management of information for the various operations; that is, primary, supportive, and development. One basic prerequisite for this is an efficient information supply; i.e., correct, unambiguous data and documents available for operational needs at a reasonable cost. An efficient information supply is promoted by uniformity of concepts, data and documents. Decisions on uniformity must be related to the data structure and be based on a survey of the various operations and their information needs.

The most important prerequisites governing EDP support consist of the positive opinion of the human element, the decentralized organization, and the areas of concentration indicated by top management. The positive opinion of the human element limits EDP as an aid in information management and leads to the following restrictions:

- * EDP support shall not cause any knowledge impoverishment
- * EDP support shall not lead to increased isolation, work monotony or infringe upon individual integrity
- * ergonomic factors shall also be taken into consideration (i.e. health risks of different kind shall be avoided).

The strategy firmly states that information be treated and administered as a strategic resource to ensure efficient information supply. Every manager, responsible for business operations, is also responsible for EDP support to them. All people, involved in a business operation, are concerned with its decision support including EDP.

In the SNRA's decentralized organization the following steering instruments are used:

- * common principles for information management (handling of data and documents)
- * structures for information management and its components
- * standards for frequent components (e.g., EDP hardware and general software) and work methods
- * organizational safeguards in information administration (IA functions).

Additionally, data storage and applications supplied on request of top management and used throughout the entire organization promote integration and serve as steering instruments.

Furthermore, an efficient information supply requires competent personnel with a positive attitude. This can be achieved through the following:

- * users regard EDP as a natural tool for their handling of information
- * users are given the opportunity to participate in the development of EDP support in order that their demands can be taken into consideration
- * all personnel receive the information and training necessary
- * personnel whose work tasks decrease or disappear completely are provided with the training required to be able to assume other tasks within the organization. (This applies, for example, to personnel involved in design drawing, data registration or typing).

Principles for Data and Document Management

The backbone of information management consists of how data and documents are handled; that is, the methods used to ensure the production, storage, distribution and access to them. In effect, it requires that every manager devote special attention to the administration of data and documents within his area of supervision in accordance with the SNRA policy on information management as well as other steering instruments.

One necessary prerequisite for data to be able to be used throughout the organization is that operations, information needs, data and other important phenomena are described in a way that is structured, coherent and comparable. A consistent terminology is necessary in order to achieve this.

Concepts and data are registered in a definitions dictionary available throughout the entire organization. References shall provide information as to who is responsible for specific data and where it can be obtained or ordered. Documents concerning the entire organization are to be listed in a reference data base available to all SNRA employees. The references shall provide information as to who is responsible for a specific document and where it can be obtained or ordered.

Uniformity with Respect to Data and Documents

Concepts, data and documents shared in various operations must have an unambiguous common interpretation. This is achieved through a decision on uniformity establishing their status and description. Decisions concerning uniformity must be related to descriptions of the operations. Uniformity decisions shall be made by every individual manager for his/her particular area of operation.

Uniformity of concept, data or document can include one or several of the following:

- definitions of concepts, data or documents
- storage of data or documents
- access to data or documents
- collection/production of data or document.

4. Information Management Structures

Information and operation structures describe operations and their information needs and constitute steering instruments for all information management. Hardware and software configurations are particular steering instruments for EDP support. Administrative models were produced originally for EDP supported information management but are being used more and more for all operations.

Operation Descriptions (Operation Structures and Information Structures)

There are to be current descriptions of all operations at the SNRA. These operation descriptions shall represent the collective views and accumulated knowledge of all personnel involved. Operation descriptions shall be freely accessible to everyone concerned.

Operation descriptions from different units shall be available for comparison and compilation into an overall picture. The ABC method shall be used as a common descriptive method.

The operation descriptions shall be produced gradually, normally as a component in the work on systems development or organizational development.

It is always the manager in charge of a certain area of operations who is responsible for the factual content, quality and current relevancy in the operation description.

Operation descriptions shall always constitute the basis for both the development and administration of EDP. This is especially important in the design of the application structures and data storage as well as when making decisions on the overall policy on concepts and data. The operation descriptions shall also be a natural tool in operation management, organizational development, internal and external information and in other contexts where data and documentation questions are involved.

Computer Utility Structures and Standards for EDP Tools

In functional terms, the SNRA has a uniform computer utility structure. There should at all times be a number of specified standards for EDP hardware and general software (so-called EDP tools) which together cover the functional requirements of the computer utilities structure in the best possible way. Both the purchase and development of EDP hardware and software follow these standards.

Program Systems Structure (Structure for Data Storage and Applications)

There is to be an established structure for SNRA data storage and applications to which every new or altered data storage or application shall be connected. A differentiation can be made between general systems for everybody (termed office automation systems at the SNRA), common data bases, and applications for specific users.

Structures for data storage are based on a division of the total data needs in the various subject areas while taking into consideration both the geographical aspects throughout the organization as well as the applications currently in use. The subject areas are contained in the information structure. The design and localization of the data storage shall ensure both the possibility of an overall view and data integrity, as well as storage and access efficiency. The long-term data needs within the organization determine the division of data into logical data storage. The extent of and physical localization of these is governed by the actual applications.

The applications structures are based on identifiable groups or situations requiring EDP support contained in the organizational structure. General program modules are developed for frequent data process routines to be used in all relevant applications.

System Administration Model and System Development Model

At the SNRA we have defined system administration as maintenance, user support (including training, information and advising), follow-up and initialization of further development of a system. System administration model incorporates a specific system development model. Related to these models is a description of the roles and responsibilities in the EDP operations. All EDP operations at the SNRA must abide by these models and role and responsibility descriptions. By the way, the models are used also for other types of resources than information systems.

5. Standard Methods and Standards for EDP Tools

At the SNRA there are standardized methods for both operation descriptions (the ABC method) as well as for work concerning EDP security. These will be supplemented with standardized methods for system development and other important elements of systems administration.

Up until the present time the ABC method has been used primarily in system development projects resulting in a couple of hundred concept and flow models. These models are currently documented in simple Macintosh graphs (MacDraw). The definitions will be included in a text data base and thereby retrievable.

Within the EDP tools area there are standards for:

- * computers, including basic software
- * computer operations system (aids and routines for computer operations)
- * data communications
- * work stations (including terminals, personal computers, printers, plotters)
- * system development system (aids and routines for system development)
- * office automation system (software for general office routines).

These standards have been used in Stage 1 of the SNRA computerization program but are now being supplemented to cover future needs. The most important supplements are concerned with EDP support for computer operations, ergonomics, work stations with computing power, graphic interface, more efficient development tools and CASE tools.

6. System Development System

Both managers and users must be given the opportunity to influence the EDP systems design both during the developmental as well as during the administrative stage. This can basically be accomplished in three ways: as clients, as user advisors in development projects or through direct involvement in the development. User influence will depend on the type of system, and on the extent of the development effort.

Development of extensive complex systems will, in the future, continue to be carried out principally by specialists. In these cases the system development models and methods must guarantee user influence. The prime task of an efficient development system is to keep costs down.

The development of less extensive systems or of supplements to larger systems is carried out advantageously by persons whose experience has been gained at the SNRA business operations as well as in the field of system development. From an EDP point of view, such people are called "semi-professionals" at the SNRA. They have acquired their business competence through their primary job, and their system development competence through 8 - 10 weeks of formal training. This latter competence is maintained and further developed through using such personnel 30 - 50% of their working time to system development within their own specific area of operations. One major added advantage of this is the not having to wait for assistance from the EDP department.

Moreover, end users can perform simple developmental contributions for themselves; they can design and retain calculations, design reports using report generators or diagram graphics, or even create their own applications with the aid of application generators. The advantages here are both the ability to adapt the system to specific individual needs as well as not having to wait for assistance for trivial developmental contributions.

In order to achieve this ideal situation we need both open systems as well as development system with tools for both professionals, semi-professionals and end users. The development tools must be integrated in order to get integrated applications. Training possibilities and support functions must be linked to the development system. According to those needs we have specified the so-called System Development System (SDS), an integrated EDP tool for system developers. There are three partly different versions of SDS for different target groups:

- * SDS-pro for full-time professional system developers (personnel working mostly in the EDP department. These can also be external consultants.
- * SDS-semi-pro for semi-professional developers (personnel working with system development and maintenance about 25-50% of their time)
- * SDS for end users reflecting the usage of OA-tools (Office Automation) for system development.

Within the SNRA we work in an integrated environment with VMS minicomputers from Digital and MS-DOS personal computers from NOKIA. The development system must therefore incorporate tools for both these environments. Both environments can co-operate in a single application: the data base and processing parts can be designed for the mini computer while the user dialogue is designed for the personal computer. The development tool must then facilitate a flexible data exchange. Developmental efficiency is favoured if integrated development tools exist in both the minicomputer and the personal computer.

The SDS is based on several integrated tools for the implementation of major system development functions working under the operative system VMS:

- * data dictionary (CDD)
- * relational data base handler (RDB)
- * screen handler (TDMS)
- * report generator (Datatrieve)
- * graphical kernel system (GKS)
- * programming languages (COBOL FORTRAN, JSP-COBOL pre-compiler)
- * end user tool Teamdata (personal data base, report generator, query language).

As a complement to these tools we have developed a menu handler, an output handler and some general program modules.

The SDS was further completed by several, to some extent integrated, specialized tools:

- * personal data base/spread-sheet/query language (Teaminfo)
- * advanced statistical functions and advanced business graphics (SAS)
- * text data base handler (TRIP, TDBS/A1).

We have also specified some other functions for which we need to purchase or develop development tools:

- * application generator (4GL)
- * graphical user interface (Windows)
- * three-dimensional design (CAD)
- * geographical information system (GIS)
- * road data base handler (our own development).

SDS is supposed to support the initial stages of system development and the methods used in them. This means that SDS must include a CASE tool. Its most essential functions are an extension of both a data dictionary and a modelling tool. The CASE tool is supposed to be used for system specification irrespective of the tool used for system implementation. It means that we must choose a flexible CASE tool, perhaps quite a simple one. It also means that we cannot expect full integration between CASE and other development tools.

For MS-DOS personal computers we have at present the following set of development tools:

- *relational data base dBase III and Foxbase (compiler for dBase)
- *personal data base Rapidfile for end users
- *traditional programming languages COBOL, FORTRAN
- *Spreadsheet 20/20 and Supercalc 4
- *diagram graphics Graph-in-the-Box
- *menu handler PC-menu
- *terminal emulator and file transfer to VAX Reflection 2+.

7. Information Administration and its EDP Support

The various structures create prerequisites for an integrated information management which, in turn, makes common data usage possible. Naturally, the structures must first be produced and then administered. The administration comprises maintenance and further development, training, information and advisory service, as well as a follow-up of use and effect. This work is termed Information Administration (IA).

Information administration is carried out on different levels. General overall structures hold the different operations together and are administered by a corporate IA policy function on behalf of the top management. Nevertheless, every manager is responsible for the production and administration of structures within his own area of operation. These are based on higher level structures but are more detailed.

Information administration can be regarded as a first stage in the system development process. Before an application can begin to be developed, it must be "placed on the map"; i.e., set in relation to the various structures. Data to be processed is specified in the information structure. The business functions to be supported by EDP are indicated in the organizational structure. The computer utility structure specifies the hardware to be utilized and the program system structure indicates the relation between the different data storage and the applications. Finally, the administration model specifies how the applications shall be developed and administered.

Information administration within the SNRA as a whole is complicated and thereby inconceivable without EDP support. EDP support is also mandatory for the co-ordination of information administration at the different organizational levels. The role of information administration as the initiator of system development places additional requirements on a close connection between development methods and the development system.

EDP support for information administration is usually called CASE tool, (CASE = Computer Aided System Engineering) or Data Dictionary (in a very broad sense of the word). CASE tools can, however, also be used by other user categories and in other connections than in information administration.

8. CASE Tool Users

CASE tools are used to handle the corporation data encyclopaedia (data on data, metadata). They will thus be utilized by various groups of users with highly varied work tasks and experience in EDP support. The most important user groups are:

- * Information administrators at the Head Office and in the line of command constitute the main users of CASE tools. These are relatively few in number, are very familiar with EDP support and place higher demands on the tool functions than on their being user friendly.
- * System designers with high EDP competence, who also place higher demands on functionality than on user friendliness.
- * System administrators whose primary competence lies in their experience in various business operations but who are also relatively familiar with EDP support and its uses.
- * Users of EDP support who require tools that are easy to use and adaptable to their operation needs. Managers can also be included in this group.

9. Functional Requirements on CASE Tools

CASE tools shall facilitate the description and handling of information management structures; i.e., their creation, storage, distribution, recovery, presentation, consistence control and comparison of different models. The most important requirements are concerned with simple creation, simple modification, fast recovery and clear presentation.

The description of the information structure shall amongst other things comprise:

- * the relation between concepts (in form of structural images)
- * the relation between structural images with different degrees of detail
- * the connection between concept definitions and structural images
- * the connection between attributes and concepts.

The description of the business operation structure shall amongst other things comprise:

- * the relation between different business functions in the form of different flows - products, material, information, money (in form of structural images)
- * the relation between structural images with different degrees of detail
- * the connection between function descriptions and structural images
- * the relation between concepts and operational functions.

The description of the computer utility structure shall amongst other things comprise:

- * the relation between the different hardware (in form of structural images)
- * the connection between the description of the hardware and the structural images
- * the connection between the hardware and the business functions.

The description of the program system structure shall amongst other things comprise:

- * the identification of the different data storages (connection to the information structure)
- * the connection between the data storages and the computer utility structure
- * the connection between the applications and the computer utility structure
- * the connection between applications and data storages
- * the connection between applications and the business functions.

There can be different levels of ambition with respect to CASE tools.

The lowest level of ambition permits only a documentation of the various information management structures. The documentation simply defines and describes the components of the structure and the relation between them. The relation can be presented in the form of tables and/or graphs.

At a higher level, demands can be made on efficient retrieval functions facilitating manual control of logical relationships.

At an even higher level, a certain degree of help for the information administrator can be obtained. This help can constitute the production of clearer structural images or of logical checks.

CASE tools shall also be able to be used for assistance in navigation within the structures. If the tools are user friendly, they can even be utilized by end users thereby serving as aids in the design of menus in the user dialogue. In certain cases these tools could even replace the user menus.

Our vision for the future is to have CASE tools to support all phases of information management, from business operations analysis and the planning of business development to the usage and retrieval of data in the final information processing system. The tools would also be able to be used for administration, operation and maintenance. A system of information exchange implying that data registered in one context could be readily transferable to another would be a reality. A comparison of data collected by different tools in different circumstances could also be made.

10. Integration Requirements on CASE Tools

Integration requirements apply partially to the integration between the different structures, partially to the integration between CASE tools and the system development system (including the methods supported by the system development system), and partially to the integration between the CASE tools and the EDP applications. The integration must bridge the gap between the different hardware, operative systems, models, terminology, data storage methods, programming languages etc.. These requirements can partly be met through the CASE tools themselves. However, extensive supplementation is probably a necessity.

Integration between the structures will make a description of the relation between the different structures possible; e.g., between data and data storage, data storage and applications, data storage and computer utility, application and business function etc.. The most important of these types of relationships are stipulated in the functional requirements.

The integration between CASE tools and the development system /development methods will primarily make it possible to use the data structures documented in the CASE tools for the construction of data storage as well as to use the standard program modules documented in the CASE tools for program development.

The integration between CASE tools and applications will allow changes in the structures to have an immediate influence on applications (e.g., active data dictionaries). This contributes to a faster and more reliable system maintenance.

11. CASE in the Planning of Business Development

Business development comprises development both with respect to the primary business functions as well as to support functions, (e.g., support production, administration of various resources etc.). It happens more and more that the business development brings about an expansion of the need for information supply and that some form of EDP support will be necessary.

When planning business development, the following must be documented:

- Business goals

These are often presented through graphs with definitions. Exactly how depends on the methods used. There is no one single prescribed method for describing goals; several are possible. In the work on goal description it can be necessary to make comparisons with results of previous work within a specific field and even with other related areas.

- Steering Prerequisites

The description points out the most important external and internal factors influencing the specific business function. The description must be done explicitly in writing but may also contain certain illustrations.

- Description of the Business Function

The description shall refer to both the present situation as it actually is, as well as to the situation desired. The documentation shall thus include two parts comprising:

- either a flowing text or information as to where such text can be found
- conceptual models
- flow models
- facts on quantity; e.g., volumes, frequencies etc.

Conceptual models define and identify the concepts used in the business function and describe their inter-relationships. Flow models identify and define functions as well as the different flows between them. Every conceptual model and flow model is part of a situation and describes a part of the total business. Each one may be linked to a certain part of the organization, but does not necessarily have to. The models as such have a certain status; i.e., they describe the business function in a given situation, for example, the present, the future, or as an idea.

- Business Functions Information Needs

This is a rough, formalized description of the information needs which have been identified during the creation of models for the desired situation.

Extensive and complex amounts of information are handled when planning business development. EDP support is a necessity for satisfactorily coping with this work.

Business development is planned both on a continual basis as well as through special investigations. Results must be documented similarly, preferably using the same tools in every situation.

12. CASE in System Development

Development of the EDP system (applications) at the SNRA is done according to the SNRA system development model. In this model, the development has been divided into the following phases: initiation, analysis, design and construction.

The first phase, initiation, is closely related to the planning of business development. It is during this phase that ideas on EDP support are described - ideas forming the basis for decisions as to whether acquisition will be through purchase or development. During this stage, a rough description of the involved business functions is done in order to set limitations for the work to follow. A rough business analysis is made for the area in question. Previous descriptions of different business functions, work routines, information requirements, basic concepts dealt with, and their connections are used.

In the analysis phase, both business and information analyses are made. The models produced in the initiation stage are processed and examined in detail. Information requirements are supplemented with demands on access times, frequencies and quality. The information bearing concepts are defined precisely, completed with identification terms and other terms, and the relations between them are analysed. The results from the initiation phase must be available in such a form that processing and detailing can be done without having to register previous results again using new tools. In the analysis phase different suggestions and solutions shall be presented and analysed. EDP support for analysis and comparison of different models is here necessary in order to see the various alternative divisions in the sub-systems. At this point it is also important to have an EDP support to check and verify the different models so that the descriptions are correct and consistent.

In the design phase the model from the analysis phase is to be defined more exactly in a normalized data model with tables, data values and rules. Work routines are specified and all information requirements checked against the data model to ensure that the information required can actually be obtained. At this stage we are approaching a traditional data dictionary and the necessity of transferring information from the analysis and documentation tools used up until now to the data dictionary connected to the data base handler in mind will be a tangible reality. Possibilities of transferring definition texts etc. to any prospective help functions in the future applications will also be needed.

In the construction phase, applications described in the design phase will become the reality. This means amongst other things that the normalized data model shall be optimized in accordance with the prerequisites in the actual data base handler. It is then natural to use the data dictionary related to this, in our case CDD+. Rules and events for different concepts should be documented at this time in such a way as to be easily used when producing both the programs as well as support texts and handbooks.

Information on existing applications and the business functions they support is required all the time when developing applications. Results from different business descriptions must be compared. Furthermore, information needs must be checked against different data models in order to be able to discover any possible similarities. As a result, existing data and existing program modules can be re-used.

13. CASE in System Administration

Administration of an application means responsibility for the continued existence of the application through maintenance and initiation of development, for the efficient use of the application through training, information and advice, and for follow-up on the functionality, use and benefit. The individual administrator must have access to extensive documentation on the application in order to be able to exercise his responsibility.

In the maintenance of an application, it has to be obvious how a change in one part of the application affects the rest of it. For example, it must be evident which programs and screen images will be affected if the size of a term is changed. Moreover, it is necessary to be able to determine whether other applications will be influenced by the change in mind.

Ideas on further development and/or termination must be analysed from the point of view of their effect on other applications, of their function in the business, on the inherent changes in the information flow, etc.. The work in these situations is comparable to that done in the initiation phase and the demands on support instruments are basically the same.

The administrator must be able to advise the users on the use of the application and be able to answer questions on the information processed by the application. For that reason, he must be able to find out which concepts the application handles, which business functions the application supports, the quality of the data in the data base, etc..

14. CASE in Information Retrieval

Three different situations are imaginable when searching for information in both traditional and text data bases:

- the person searching knows where the data is stored, he is used to searching for this data and wants it presented in the way he normally gets it from the application he always uses
- the person searching knows that there is data stored but does not know which application to use to access it and/or does not know how the data can be presented in the application
- the person does not know if there is any data stored.

In the first case, there is no necessity for retrieval support instruments. In the other two cases a retrieval support instrument is needed that is identical to, or based on, CASE tools.

In order that the person searching can judge the usefulness of the data obtained, he must have access to their definitions as well as information on their quality and relevance.

An example of a question could be, "How high have the costs for pavement work been during 1989?". In order that the person posing the question can know that the answer he receives is relevant, he must have information on several points; for example, on the definition given to "pavement work" in the data base from which the answer has been obtained, on the way costs have been calculated (are all types of costs included?), on how up-to-date the data is (what are the most recent months included?) etc. An answer that there is no data requires further analysis. Does the answer in effect mean that there is no data, or does it mean that the question was formulated in the wrong way? Information on quality, relevance and definition of data must, therefore, be documented so that it can be decided whether or not a question is worth posing.

Another type of question is concerned with definitions of concepts. An investigator or someone responsible for a business function can wish to know how "road" is defined at the SNRA and if the same definition applies throughout the entire organization. He could, for example, want to know how productivity is calculated in different applications. In these cases, the questioner is probably not interested in specific values, but rather is satisfied with the information available in the data dictionary.

15. CASE Tools and Document Data Bases

The foregoing has been concerned with the use of CASE tools for handling data structured in table form. However, a great amount of the data in a corporation is contained in documents; i.e., flowing text sometimes including illustrations. It is naturally desirable that CASE tools also be used for information retrieval from documents.

The SNRA computer supported document handling system comprises:

- a reference data base containing information on documents of common interest. The reference data base provides references both to documents stored in computer readable form as well as to other documents. The content (in the form of short summary, keywords and subject areas) as well as the storage place is described for every document.
- full text data bases with computer stored documents of common interest
- a record data base with information on incoming and outgoing documents
- a library data base with information on the literature inventory there.

The selection of keywords used in the reference data base is currently free and unrestricted, but in the future a specific pre-determined keyword list, a so-called thesaurus, will be used. This list shall be based on concepts defined and listed in the data dictionary produced using CASE tools.

The current subject area classification in the reference data base has been done according to two older classification systems. These should be supplemented with the subject areas in the data dictionary.

When this has been done, the person seeking information will be guided by CASE tools to the correct data irrespective of whether this is stored in structured tables, computer readable documents or other types of documents.

16. Action Plan for the Acquisition of CASE Tools

The present course of action is as follows: (the dates are preliminary)

1. Selection. Ready July 1, 1989.
 - * Production of requirement specifications for CASE tools and harmonization of these with conceivable methods and requirement specifications on EDP tools.
 - * Theoretical harmonization with the market supply: Ramatic, Excelerator, Programmers workbench, IEW, Deft, Speedbuilder and any possible others.
 - * Rough selection.
 - * Practical tests on SNRA material.
2. Purchase and adaptation (can be done gradually). First version ready November 1, 1989.
3. First version operational. December 31, 1989.