

## **The role of Norwegian Building Standardizing and the use of advanced computer methods in building and civil work design and project management.**

**Odd Lyng, director of Norwegian Building Standardizing Council, Oslo**

**Sverre Vagle, managing director of Data Design System Ltd., Sandnes**

**Janusz Ziolkowski, civil engineer, Ziolkowski & Co Ltd, Consulting eng. on project management, Oslo**

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**Abstract:** The Norwegian national standards NS 3420, NS 3421 and NS 3451 are unique on a world basis, their concept as well as the resulting coding system and text elements. This idea being carried through to practical results may well be the reason why Norway has been able to establish such an advanced position, as compared to other nations, in the exploitation of computers in project management.

### **Norwegian building standardizing**

#### **Introduction**

A precondition for efficient use of computers in the total building process and also in management and maintenance of the building process is a set of common rules related to processing and presentation of data.

To develop such rules and to give sufficient authority so that they are accepted by the industry requires cooperation from the different parties in the industry.

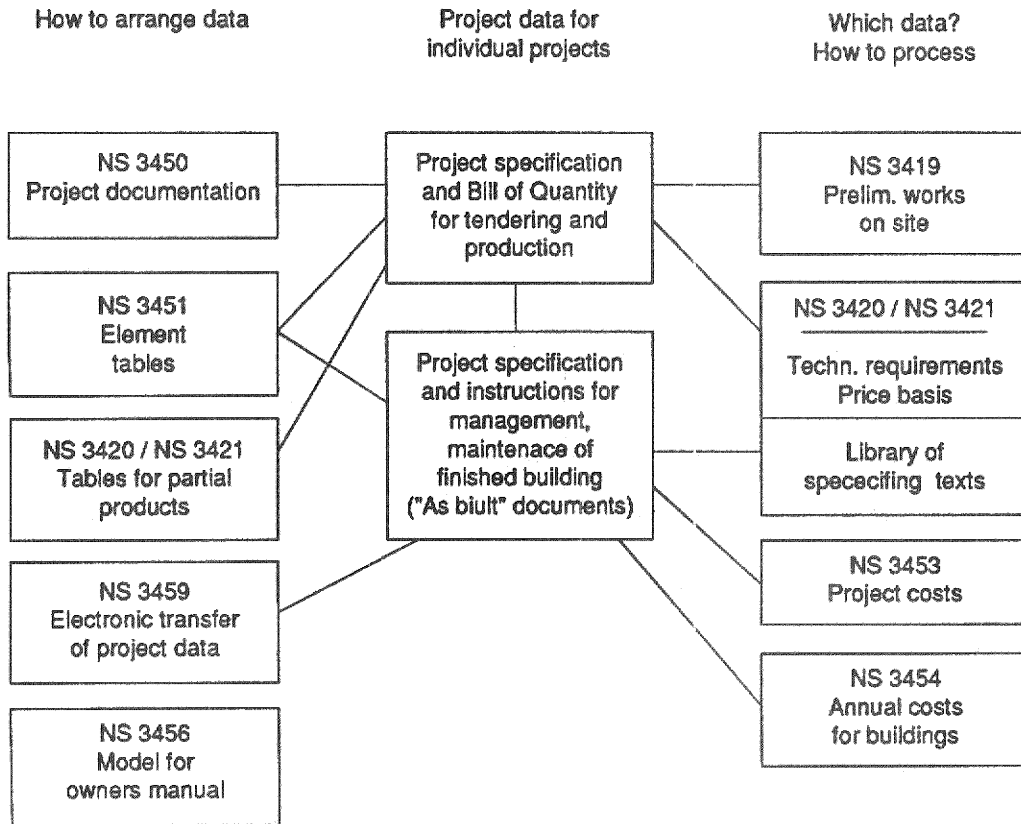
The Norwegian Council for Building Standardization therefore back in 1966 started on a big program to develop the necessary rules and publish them as Norwegian Standards.

Today a number of such standards are in force. Together they create a "data infrastructure" for the building and civil engineering industry and are the basis for almost all computer programs used in Norway for processing and presentation of project data.

The figure on next page indicates the system of standards, their interrelation and how they are used to produce and communicate project data for individual projects. In addition to these standards there are a number of others which are important but not directly connected with use of computer.

The standards shown in the figure together form a common system that is a basis for much of the design work and management of building projects. Consequently today nearly all data on different individual projects are arranged in a standardized way which makes it easier to communicate and cooperate between different individual systems and firms.





### The standard structure

The basic structure today consists of two hierarchically arranged tables which both permit different degrees of detailing. The building element table (NS 3451) has three levels as shown in the following example:

2.	Tables for building elements
2.1	Main parts
0	-
1	-
2	Building
3	Ventilation, Water, Sanitary Installations
4	Electric Power Installations
5	Tele and Automatization
6	Other Installations
7	External
8	-
9	-
2	Building
21	Foundations
22	Load bearing system
221	Frames
222	Columns
223	Beams

The tables for partial products (integrated in NS 3420 and NS 3421) give the structure for parts that build up building elements e.g. weather boarding, vapour sealing, trench in soil.

In addition to these two tables the Sfb system is used for building products (resources).

All data that relate to physical parts of the building are grouped in accordance with these tables. Examples are technical specifications, budgets and costs, minutes from site meetings, maintenance plans.

The tables are often combined with tables developed for an individual project, an individual firm or computer program.

Part of the structure are also some rules on the use of the tables and definitions e.g. definitions and rules related to types of project documents.

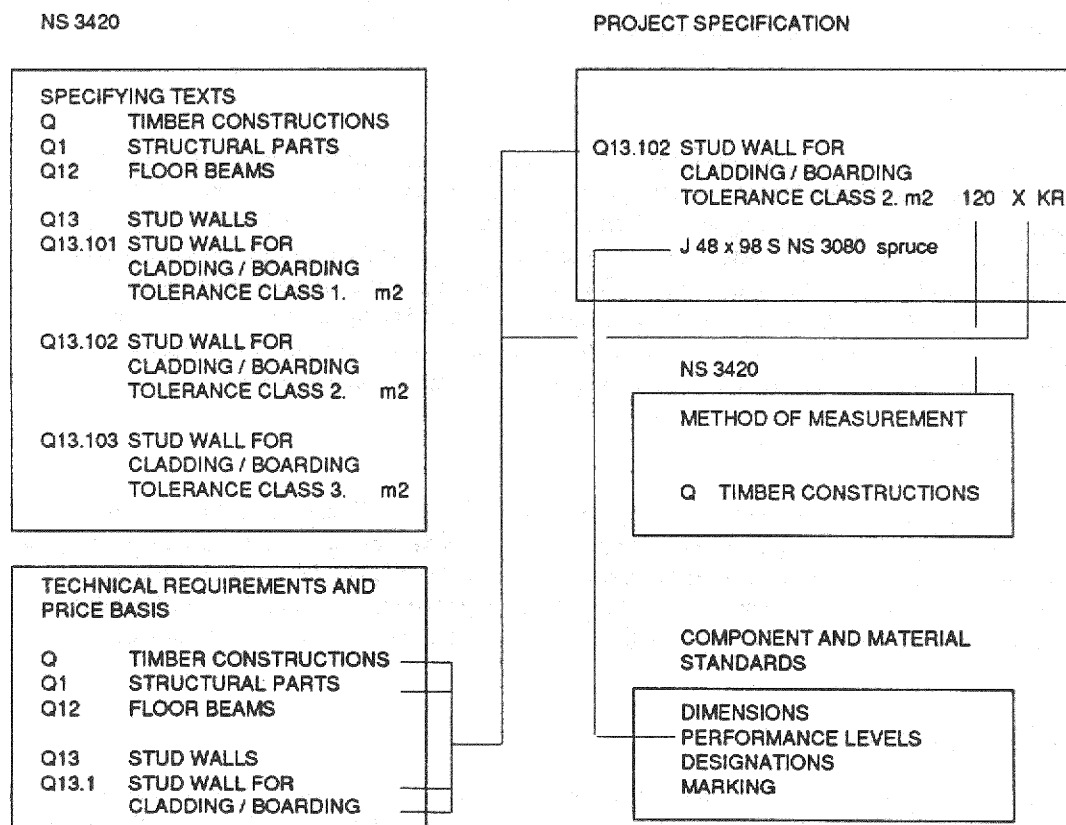
### The data

In the same way as the erection of a building is rationalized by the use of prefabricated parts, bricks, windows, boilers etc., the "intellectual erection" of it - design, specification writing etc. - can be rationalized by use of "prefabricated" data packages that can be put together in different ways to make a specification of a building element.

Two standards contain such packages, NS 3420 for construction works, and NS 3421 for installations. Each of these standards contains a library of short specifying texts - e.g.

**Q13.102 STUD WALL FOR  
CLADDING / BOARDING  
TOLERANCE CLASS 2.**

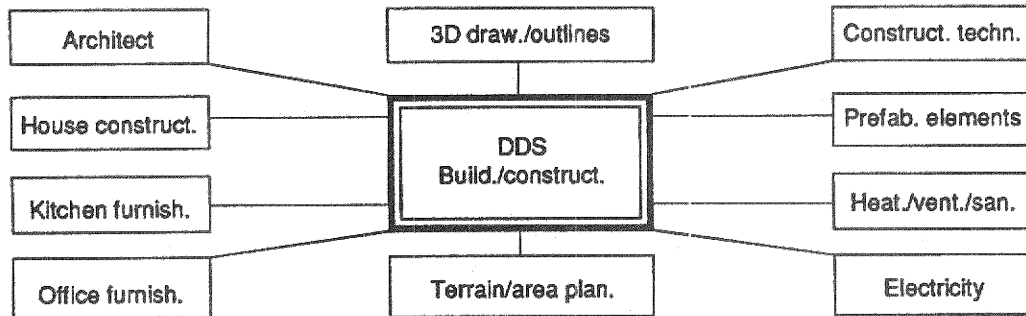
Each such text carries an individual code. The code alone can be used when this is convenient. The first part of the code is classifying and refers to technical requirements, price base and methods of measurement which apply to the specifying text. How this works in connection with the technical specification and bill of quantity is illustrated in the figure below.



All the 35.000 texts (items) in NS 3420 and the 45.000 texts in NS 3421 are available on computer readable medium.

**DATA DESIGN SYSTEM Ltd.** is a Norwegian CAD software development company, offering a PC-based program toolkit to the building industry.

### The Data Design System



Constructed using today's powerful, cost-effective micro computers, over a period of eight years intensive development in close co-operations with the end-users, of which there are now over 500, these special programs combine to make the most comprehensive "Toolbox" available to professionals.

All applications are designed to guarantee smooth integration with the tools used by the other members of the project group.

The Partners are based on a new powerful, fully 3D drafting program. Thus the user can draw parts/components and details in 2D and 3D completely independently of the special applications.

#### ARCPARTNER.

ArcPartner is brand new, and has been developed to reduce the amount of work an architect has to do and to increase his efficiency in the various phases of programming, pre-project work and detailed projecting. With straight-line diagrams, 2D and 3D, sketch plans, details, scaled wire and surface models, the architect will be assisted in determining sizes, shapes and means of expression. Furthermore, the architect can build up a complete 3D model of the relevant building just by using ArcPartner's functions and figure library of building sections and components. You can retrieve drawings from the model in a particular scale in 2D or 3D, axonometric or perspective, perspective, with automatic dimensioning, perspective, shadowing and quantitative calculations etc.

#### HOUSEPARTNER.

HousePartner provides housing companies, prefab house builders, building contractors and other firms in the small-property building trade with a highly effective method of planning and producing relevant building drawings. As well as great flexibility, HousePartner has built-in functions and details which cover the most common situations in today's home building market. So, in this way, the planning functions can really be automated, even in the fields of quantitative listings and cost analyses.

#### KITCHENPARTNER.

KitchenPartner meets the requirements of kitchen showrooms and dealers regarding the planning of kitchens and the production of 3D drawings. The administrative part of KitchenPartner will increase efficiency of routines and ensure smooth production and delivery operations.

#### OFFICEPARTNER.

OfficePartner has been developed for use by interior architects, retailers of office furniture, trade fair agencies and other businesses. Planning routines, 3D visualisation and administrative routines have been integrated with parametric figures and a figure library to make a highly effective design and sales tool.

## TERRAPARTNER

TerraPartner - This is a completely new program forming a unique tool for terrain planning and 3D visualisation. Map data may be read or digitised into the system. Buildings, roads and other changes to the terrain can be positioned. The user is offered a selection of standpoints from which to consider the result and, furthermore, can ask the system to carry out quantitative calculations and draw an excavation plan. Ground data gained from drilling can be entered into the system, making it possible to handle up to ten different strata ( rock, earth types etc. ) at the same time.

## PREFABPARTNER.

PrefabPartner consists of a selection of programs suitable for the design, calculation, offer and production planning of prefabricated sections (Spenncon, Leca; Siporex etc.) Prefab Partner has been designed in such a way that it can be adapted to the individual requirements of any particular company.

## BUILDINGPARTNER.

BuildingPartner is also a new program. Primarily, this produces form and reinforcement drawings with bar schedules. By using BuildingPartner's functions, the professional engineer can produce the appropriate component drawings based on the architect's drawings. The adding of text, dimensioning and quantitative calculations are almost completely automated. In an accurately scaled component drawing, the location of reinforcement bars will give the correct dimensions and numbers. Transfers to, and printing out, bar schedules are automatic. In due course, BuildingPartner will be expanded to include special modules for steel, wood and brick buildings.

## ELECTROPARTNER

ElectroPartner is a new and more comprehensive version of the Electro Package and contains special modules for installation- and circuit-drawing. In addition to efficient drawing and circuit production, full 3D information gives automatic quantitative calculation when connected to National Building Standards. It is also set up to be connected to other technical calculation programs.

## HVACPARTNER

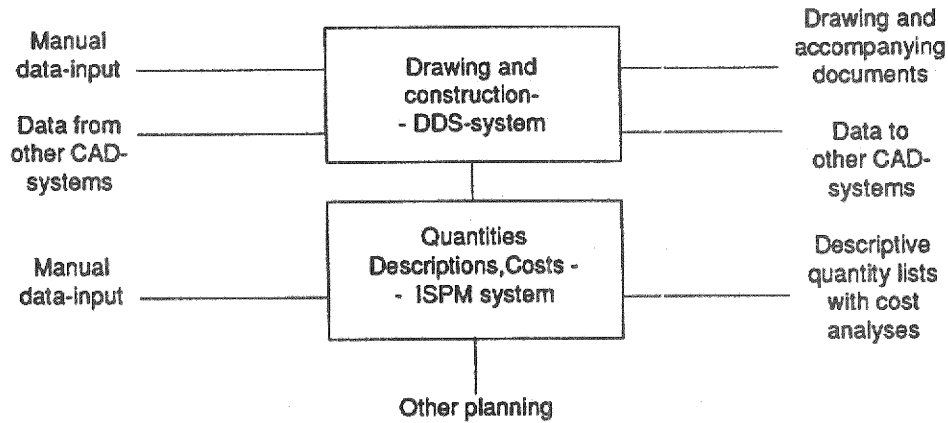
HVACPartner is a new program suited primarily to the requirements of mechanical engineers and dealers in HVAC and sanitation equipment. It contains special modules for HVAC and sanitation facilities. HVACPartner performs drawing tasks with NS 3421. It is also set up for use with technical calculation programs.

The designer may work in 2D and 3D simultaneously. Working with the system's 3D facilities offers many new advantages. The user may look at the object from any chosen angle and distance. Plans, elevations and cross-sections are generated automatically, scaled and detailed, including text, hatching and dimensioning, selected by the user. Isometric views and perspectives with automatic shadowing, from any chosen angle and distance, is included.

The 3D modelling allows high quality quantity calculations. The system will guarantee a quantity file with all relevant data, which in turn may be transferred to the ISPM system for further treatment, according to the figure shown on the next page.

The Partners are designed to be able to work in conjunction with administration, description and calculation programs and, in some cases, technical calculation programs. Some of these are already connected.

The Data Design System is written in standards Fortran 77 and runs under MS-DOS. Using standard powerful and costeffective microcomputers, the system has proven to be fast and flexible at a reasonable price.



It can handle small and big projects with surprising speed and quality. Communication between different CAD systems is important to the users. Such communication is currently established between Prime Medusa and Data Design System. The system can also communicate efficiently with AutoCad.

Great effort has been made to ease and control the communication between the different trade colleagues in the project group.

This important task is carried out in close cooperation with the different involved parties / trades / professionals and the Norwegian Building Standardizing Council.

The Data Design System is developed in Norway. It has nearly 600 users in 10 European countries.

All applications are designed to guarantee smooth integration with the tools used by other members of the project group.

The Partners are based on a new powerful, fully 3D drafting program. Thus the user can draw parts / components and details in 2D and 3D completely independantly of the special applications.

### **Integrated System for Projects and Management**

Ziolko & Co A/S is a consulting engineering company, member of RIF, Norwegian branch of FIDIC, and works in the field of project management. Ziolko & Co A/S has developed the ISPM system.

The ISPM system - "Integrated System for Projects and Management" is a comprehensive system of programmes working together. With this tool specifications and related documents can be set up. When one knows the system with all its opportunities for increased efficiency, one will save time and gain other advantages, not least in the form of better service to customers.

Much information will have to be coordinated in order to produce a bill of quantity - the central document in the administration of building projects. Most people associate the terms 'specification', 'tender document' etc. with the document used for tendering procedures on a building project. The bill of quantity may mean more than this.

By means of the ISPM-system the following functions can be carried out:

- room programmes
- cost estimates
- specifications
- bills of quantity
- tender documents
- tender controls
- tender analyses
- agreement documents
- invoices
- change-orders
- room surveys, support material for production
- final settlement
- 'as built' documents
- maintenance of building.

The ISPM-system, expanded with additional modules, also allows automation of material take-off from CAD-system DDS.

Mester-ISPM is a separate module within the ISPM system. The purpose of this module is to provide the user with an efficient tool for calculating unit prices and lump sums that are specified in tender documents, and for producing the tenders that will be submitted to the client. Mester-ISPM may be used for calculation jobs (tendering) carried out by

- building and construction contractors
- electricians
- sanitary contractors
- producers of pre-fab housing
- engineering workshops.

The system is flexible and the user may specify the level of detailing for a price calculation job according to his own needs. The system offers a number of options for selecting bases for building up unit prices.

Any coding system may be used for coding tender items as well as resources with Mester-ISPM. The codes NS 3420 and NS 3421 may for instance be selected as a basis for tender items, while the supplier's commodity number may serve as resource code. Development of the ISPM system has been based on traditional Norwegian rules for project management. The system is conditioned for use with standard specification texts and free texts in combination.

Parts of the system concerning tendering have been developed on request by the Norwegian House Builders Association. It has been government sponsored through the national 3B Development Programme.

Norwegian Tinsmiths' Association, Norwegian Painters' Association and Norwegian Bricklayers' Association have also chosen Mester-ISPM as tendering system. A new system concerning certificate of measurement for contract work has been developed on request by Norwegian Building Workers Association (Trade Union). This system is also linked to Mester-ISPM.

As a result of this computerized system for Bill of Quantities and price calculation, the demand was growing for a related control system. The 3B Programme has furnished support also for this new ISPM-module - Drift-ISPM. The purpose of this module is to provide the builders and contractors with an efficient tool for tender analyses, time scheduling, building accounts, reporting of time and material consumption, status reports, final settlements as well as control of prices, and cost analyses. This system is directly linked to the BQ-main module.

Mester-ISPM and Drift-ISPM have both been developed in close cooperation with the most advanced specialists within the house building trade in Norway. 150 Norwegian builders and contractors use the BQ- and tendering system Mester-ISPM.

Advising clients Ziolk & Co A/S encourages them to use Norwegian national coding concept as the base for organization and treatment of data within building- and civil works projects. The Norwegian national coding concept is simple, easy to understand and, the most important - it is working well in practical life. It consists of the following set of standards:

NS 3451 - "Building Elements" covering the needs for identifying the final products in the building industry,

NS 3420 / NS 3421 - "Standard specifications for building, civil works and technical installations" supplying the main items, about 80.000 in all, for partial products, in form of structured and codified libraries, and

SfB- table 3. - "Resources", to classify labour, material and plant, necessary for price calculation.

From the systematical point of view "Building Element" represents the final destination to allocate the resources. "The partial products", placed between building elements and resources, is the abstract facet of the whole system. Working methods, licenses, professional knowledge, regulations - all these factors which describe the building process and ensure correct assembling of raw resources into final products -

are named "partial products".

The Norwegian coding concept corresponds to common principles of production organization and has been improved in connection with a series of large development oil projects in The North Sea. It is important to note that the model is dynamic - spiral formed - relative to final consumers requirements. This relativity is imposed by the fact that final products from a given part of the industry represent resources for another part of the same.

The Norwegian standards, NS 3451 combined with NS 3420 / NS 3421, give a clear code structure for the organization of specifications and bills of quantities as well as all other documents necessary for the management of building and civil work projects.

The structure of codes within NS 3420 / NS 3421 and their detailing levels have a fortunate composition. The standard specifications are limited to cover quality requirements and measuring rules. Architects and engineers working on projects have full freedom to add adequate information to define a particular solution.

Thanks to these properties the Norwegian standards NS 3451 and NS 3420 / NS 3421 have a large spreading and high percentage of application. Standards are used not only by specialists and technicians on higher level of administration of the building process. The craftsmen on the site are able to understand the main codes and read the meaning behind them. The Norwegian Trade Union when establishing a computer based system for certificate of measurement, has accepted the SFB code for resources.

The ISPM system profits from the ability of Norwegian standards to express both the general rules and special requirements, and offers their users the possibility to work on three levels:

- national standards,
- company standards and
- special project requirements.

Several large Norwegian architect and engineering companies, and organizations have built up, on the basis of national standards, and by means of the ISPM system, their own specification catalogues. Company or organization catalogues are collections of texts supplementing the national standards. Such catalogues contain texts which may be used from project to project.

The project catalogue is a collection of texts set up in such a way that they are connected to time and location, they are only applicable for a given project and cannot be directly used in other projects. For that reason these texts do not belong in company catalogues.

The following example illustrates the relationship between texts collected from the three catalogue types:

#### National standard

L53.122 CONCRETE WALL. TOLERANCE CLASS 2.  
NORMAL CONTROL.

#### Company catalogue

L53.122 -01 Concrete quality C 25.

#### Project catalogue

L53.122 -86 Front wall facing Henrik Ibsen Street.  
Location of construction joints to be  
arranged with the architect.



Among the companies and organizations working according to the above mentioned principles are:

Bonde & Co	- standard for concrete constructions
Østlandsconsult A/S	- standard for infrastructure
Østlandsconsult A/S	- standard for under-sea pipe lines
IGP	- standard for electrical installations
Flatheim A/S	- standard for HVAC installations
Carpenters' Association	- standard for timber structures
Tinsmiths' Association	- standard for plate covering
Painters' Association	- standard for painting and
Bricklayers' Association	- standard for brick, plaster and tile structures
Trade Union	- tariffs for all types of work

The mentioned companies and organizations offer their catalogues for free sale, unlimited to own commercial connections.

One of many encouraging examples of collaboration between different partners in the building industry is the one concerning The Houses Bank of Norway and Norwegian Builders' and Carpenter' Association. The Bank is using specifications and "price package" catalogues developed by The Carpenters to evaluate the cost of houses to be financed (about 50 % of houses built in Norway are timbered). The same Carpenters' Association allows also Block Watne Ltd. access to their catalogues. Block Watne is the largest Norwegian company producing houses, and - the main competitor to the members of the Carpenters' Association.

To complete the stage of development of high information technology within the building industry in Norway it is necessary to mention the important contribution of the Trade Union. This organization has created a databank consisting of about 20.000 items covering tariff regulations for all activities within building- and civil work projects. The main task was to build up a system for certificate of measurement for contract work - Målebrev-ISP. Once the system has been created it is of great importance to the opposite party - the employers' associations of Painters, Bricklayers companies and so on, working with the tendering system Mester-ISP. The Trade Union sells their tariff catalogues to them.

A combination of price lists and tariff wages represents a perfect "package" for price estimates and tendering procedures. The example below is taken from the Painters' Association tendering catalogue. The part product code, as well as the standard text correspond with NS 3420. The connected resources are coded by SFB table 3. The tariff codes and texts are directly taken from the Trade Union catalogue. Material codes correspond with the Association's common catalogue for commodities.

T71.123 WATERPROF PVC COATING. TOLERANCE CLASS 2. m2					
Res.	Text	Un.	Un.qty	Rate	Price
c22302	Light scratching	m2	1,00	1,40	1,40
c22608	PVC in wet room	m2	1,00	26,55	26,55
c22702	Machinal smoothing of joints	m2	1,00	2,05	2,05
v4869	Casco glue P3442	l	0,25	21,00	5,25
v0876	Tarkett Optima	m2	1,15	81,30	93,50
v0880	Tarkett welding	m	0,30	1,50	0,45
total					129,20

The practical results obtained in Norway proves that a comprehensive system of national standards can be an important contribution to the development of high information technology within the building and civil work industry. This industry is responsible for about 40 % of the national product, corresponding to 60 billion NOK in 1987. It consists of about 10.000 companies, with 12 employees in average. It is thanks to the existing standards, which are accepted and used on all levels of production and by all parties, and the extended co-operation between them, that the Norwegian building industry can presents such results.

The flexibility of the ISPM system and logic of the Norwegian national codes have recently been proved by the implementation of the system, together with the DDS system, in one of the largest Czechoslovakian building companies - O.P. Prumstav in Praha, with 10.000 employees. The differences between the two opposite economical systems has not created any problems to the introduction of the Norwegian management system. The Czechs have adapted many logical solutions connected to the Norwegian Standards and the system.

More then 500 ISPM systems are installed in Norway and abroad. Among the users are:

- Norwegian State Energy Authority
- Norwegian State Houses Bank
- Norwegian State Railways
- Norwegian State Highway Authority
- Municipality of Oslo, Bergen, Stavanger
- County Architect in Hedmark and Nord-Trøndelag
- Association of Norwegian Builders and Carpenters
- Association of Norwegian Tinsmiths
- Association of Norwegian Painters
- Association of Norwegian Bricklayers
- Norwegian Construction Workers' Union
- O.P. Prumstav, Praha