Distributed Cooperative Budget- Planning and - Control

Prof. Dr. Eckart Zwicker
Claus Rottenbacher
In: König, W.; Kurbel, K.; Mertens, P. (Hrsg.),
Distributed Information Systems in Business

Berlin 1996

Distributed Cooperative Budget-Planning and -Control

Eckart Zwicker, Claus Rottenbacher

Abstract

This presentation summarizes our efforts to implement a budgeting computer system, named INZPLA, that allows managers to realize a cooperative budgeting and control system for decentralized organizations applying network- and database-technology in a distributed environment. The INZPLA system is based upon the theory of ITP. The theory determines INZPLA to be a highly specified application of commonly known technology of equation based systems. It enables a complete decentralized budget planning and control procedure to be performed. Up to now, equation based systems have not been employed for this economic purpose. We have found that the application of an equation based system has significant advantages.

INZPLA is a client server application based on a relational DBMS.

1. Introduction

Everywhere in business the trend towards decentralization of responsibility to managers down the line can be observed due to increasing complexity of markets as well as the internationalization of many companies. Many authors demand the 'entrepreneur within a company' to have autonomous profit responsibility and wide ranging freedom to act. They would like companies to shift towards profit-centre organizations.

Information technology systems must be developed to meet this trend. However, large-scale development of corporate software should be founded upon a thorough economic theory.[78]

In part two the theory of 'incremental target planning and control' (ITP) will be outlined. Part three describes the INZPLA computer system and the hard- and software applied for the development.

---

[78] Scheer (1990), p. 15.

2. Theory of 'incremental target planning and control' (ITP)

2.1. Introduction

ITP ('incremental target planning and control') has been developed by Eckart Zwicker at the Technische Universität Berlin.[79] It is a normative theory for budget planning and control. ITP is based on the leadership style 'Management By Objectives' (MBO). Management By Objectives is a leadership style 'specifying that superiors and those who report to them will jointly establish objectives over a specified time frame, meeting periodically to evaluate their progress in meeting these goals.'[80] However, it is extended and formalized into a consistent and general theory for budget planning and control.

Negotiations between executing and leading departments about the objectives for a planning period are an integral part of the ITP theory. At the outset of negotiations executing and leading departments tend to have different opinions about objectives. The ITP concept provides a special, structured method to define the two negotiation positions and to reach an agreement between the two groups of interest, using a three step planning procedure which will be described in chapter 2.5.

2.2. The ITP model

The ITP theory rests on the incremental target planning model (ITP model). Exhibit 1 shows its basic structure.

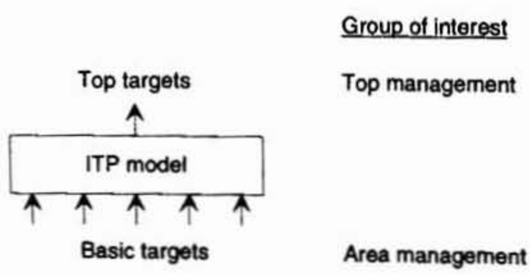

Exhibit 1: Basic structure of an ITP model

The ITP model consists of equations. The equations for an application in a firm must be determined by the user. These equations link the so called *top targets* with the so called *basic*

---

[79] See Zwicker (1988).

[80] Rosenberg (1978), p.281.

investment (ROI) or cash-flow. Basic targets are targets of the executing departments (area of responsibility, AOR) such as sales volume, demand rates (e.g. in tons per hour) or fixed costs. Basic targets are the objectives of the AOR's.

The ITP model is an equation system linking the targets of top management with the targets of executing departments (AOR's). Each AOR is defined as an independent profit-centre. It has its own equations and forms a small self-contained ITP model (AOR model) which is subsequently used for decentralized budgeting.

```
SEGMENT PC_1:
operational_profit_PC1.Y = earnings_PC1.Y - costs_PC1.Y
earnings_PC1.Y = price_PC1.Y * sales_volume_PC1.Y
costs_PC1.Y = variable_costs_PC1.Y + fixed_costs_PC1.Y
ENDSEGMENT

SEGMENT PC_2:
operational_profit_PC2.Y = earnings_PC2.Y - costs_PC2.Y
earnings_PC2.Y = price_PC2.Y * sales_volume_PC2.Y
costs_PC2.Y = variable_costs_PC2.Y + fixed_costs_PC2.Y
ENDSEGMENT
```

Exhibit 2: ITP model for profit-centre budgeting

All equations of one AOR are contained in one segment. The ITP model in exhibit 2 has two segments. Each segment has two basic targets (`sales_volume_PCx.Y`, `fixed_costs_PCx.Y`). In order to reduce the number of objectives that must be negotiated, the results of equations that are influenced by basic targets are recombined into a new equation, resulting in a single new objective, the area target. The area target in exhibit 2 is `operational_profit_PCx.Y`. As a matter of fact the area target of an AOR is always operational profit.

With the area target being the new objective of a profit-centre, there is no further obligation to meet the values of basic targets. Basic target values can now vary and must be adjusted to meet the value of the area target.

Once the area targets of all AOR's are established they can then again be combined into another single area target (see exhibit 3).

```
SEGMENT HEADQUARTER:
operational_profit_HQ.Y =    operational_profit_PC1.Y +
   operational_profit_PC2.Y -
   overheads.Y

ENDSEGMENT
```

Exhibit 3: Equation of a superior AOR

Taking overheads into consideration, `operational_profit_PC1.Y` is added to `operational_profit_PC2.Y` and results in the area target of the so called headquarter AOR. The area target of the headquarter AOR is the top target of an ITP model. The headquarter AOR is not only responsible for its own area target but also the area targets as well as the basic targets of all subordinated AOR's.

So far a rather rudimentary description of AOR models has been presented. It is important, however, to mention that is is possible to consider any number and sort of accounting and organizational issues (e.g. choice of transfer prices, determination of overhead costs share for AOR's) when AOR model equations are constructed.

2.3. The global ITP model

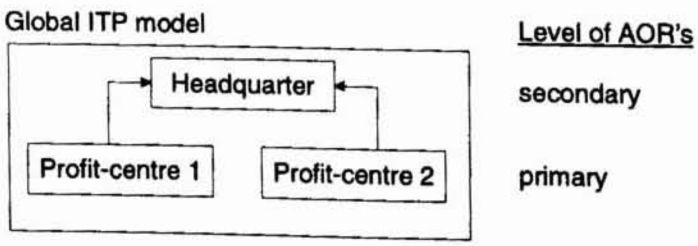

Exhibit 4: Global ITP model

The sum of all equations of all AOR's is called the global ITP model. In the global ITP model AOR's that aggregate area targets of subordinated AOR's into a single area target are called secondary AOR's. Secondary AOR's are leading departments. The highest secondary level always represents the corporate headquarter.

Executing departments are called primary AOR's. Exhibit 4 shows an example of a global ITP model with only one secondary level; however, there can be a hierarchy of secondary levels. A global ITP model for profit-centre budgeting is always organized hierarchically, because even if there is only one secondary level, several area-targets of AOR's on the same level will be combined into one area target of the headquarter AOR.

2.4. The four states of basic variables

Mathematically, both top and basic targets are variables within an equation system, the ITP model. To be more specific, basic targets are one state of basic variables. In total, there are four states of basic variables, see exhibit 5.

States of basic variables

- basic targets
- decision parameters
- uncontrollable basic variables
- objectionfree basic variables

Exhibit 5: States of basic variables

The differences between the states are as follows:

(1) The basic targets are the 'objectives' as described by MBO. The AOR's are responsible to meet their basic targets. The sets of basic targets of the AOR's are mutually exclusive. Thus each AOR is responsible for different basic targets. Values of basic targets are initially set by the area management. The values are voluntary target obligations and will change during the planning procedure. (see in 2.5). At the end of the planning procedure the values of basic targets become the objectives for the AOR's.

(2) Values of decision parameters are set by the top management and will remain unchanged throughout the planning. Examples are product sale prices or the desired inventory at the end of the planning period. The values of decision parameters are fixed. Decision parameters are always totally controllable.

(3) Values of uncontrollable basic variables are estimated for planning and usually remain unchanged during the planning procedure. An example is the currency exchange rate. When the values of uncontrollable basic variables do change, the variations then lie beyond a firm's sphere of influence. AOR's cannot be hold responsible for deviations between planned and

real values of uncontrollable basic parameters. Uncontrollable basic parameters are not objectives that have to be met.

(4) Objectionfree basic variables are rare in corporate accounting systems. An example is the loan change rate. The state of objectionfree basic variables is special. Variations of their values have no influence on the AOR's in meeting their objectives. Therefore, values of objectionfree basic variables are not determined exactly till the end of a planning procedure. They are changed and adjusted once or several times within a planning procedure in order to optimize top targets.

The distinction between the four types of basic variables has considerable implications:

(1) Once the equations of an ITP model are determined, all basic variables can and must be classified into one of the four states described above. The classification guarantees that only basic targets, which are controllable by AOR's and therefore need to be negotiated, will in fact be negotiated.

(2) Sometimes the state 'objectionfree' can be assigned to one or more of the basic variables in an ITP model. It is then possible to adjust those basic variables in order to optimize top targets, without affecting the commitment of any AOR to meet its objectives. In this case negotiation of objectives and optimization are not contradictory.

2.5. The three step planning procedure

The planning procedure includes (1) the bottom up step, (2) the top down step and (3) the bottom up top down step (confrontation), see exhibit 6. In the following these three steps will be discussed in detail.

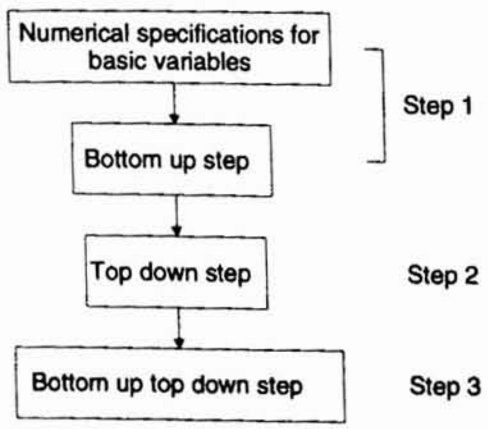

Exhibit 6: The three step planning procedure

Bottom up step

In the bottom up step the AOR's must provide numerical specifications (bottom up values) for all basic targets.[81] Once the values of all basic variables are given, the area targets can then be calculated. The area targets represent the negotiation position of AOR's.

Top down step

The top down step serves to present the negotiation position of the top management. The top management usually postulates a higher operational profit than the one resulting from the bottom up step.

Top targets are calculated from basic targets by means of equations. In order to determine the top down value of a basic target, the top management specifies a load margin for each basic target, that is the highest admissible change towards increased load.[82] For example, the sales volume of a certain product can only be increased by +10% due to the limit of maximum market demand. If the basic target is a cost target the additional load percentage would show a negative direction. Once the load margins are specified, basic target values are then adapted within their individual load margin in order to reach the top targets postulates of the top management. This is done by an optimization procedure.

At this point of the planning procedure the two initial positions for the negotiation process are established: (1) the position representing the interests of the area management which has been determined in the bottom up step and (2) the position representing the interests of the top management which has been determined in the top down step.

Bottom up top down step

In the bottom up top down step ('confrontation'), the final numerical values of the area targets are negotiated between top management and the management of all primary AOR's through another adaptation of the values of basic targets.

Each basic target influences the top targets differently. Some basic targets have a greater influence on the value of top targets than others. The degree of influence of one specific basic target is represented by a parameter. This parameter depicts the change of a top target value resulting from a 1% change of a basic target value. Consequently, it is possible to devote the main attention to the basic targets of greater influence.

---

81 Specific persons are authorized to enter bottom-up-values of the other basic-variables.

82 The idea of establishing load margins is based on the theory of 'Organizational Slack', see Cyert, March (1963).

The determination of the final numerical values of area targets preceeds on the determination of specific values for the basic targets. In the AOR's these values are called accepted basic targets because they represent one possible combination of figures that will definitely fulfill the agreed area target.

Due to the option of choosing different sets of basic target values, the actual value of the headquarter area target will probably differ from the planned value, even when the planned values of all area targets are met. The deviation of actual top target values from planned top target values can be represented graphically. The range of values within which top target values can vary is called the uncertainty area of top target values. An example of the uncertainty area of two top targets is shown in exhibit 7.

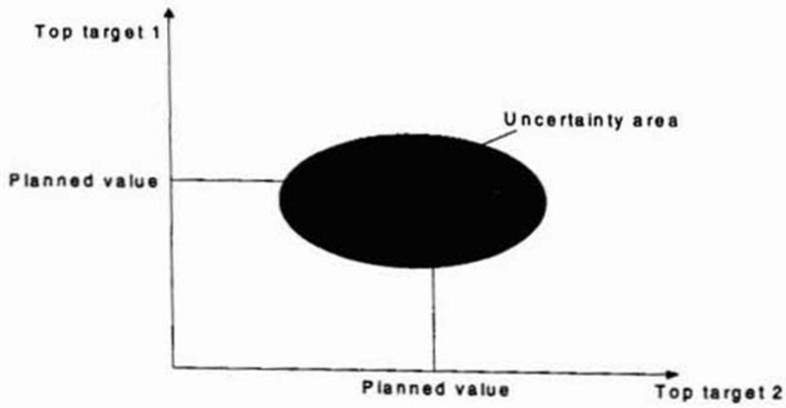

Exhibit 7: Uncertainty area of two top targets

The top management must define an admissible region for the choice of each basic target value in order to be able to influence the size of the uncertainty area. The more the top management limits the choice of basic target values, the smaller will be the uncertainty area of top target values and the less will be the deviation of actual from planned top target values. It is important to mention that the accepted basic target values must always lie in the admissible region of the basic targets. The admissible region is called 'area of variation'.

The possibility of showing and comparing different uncertainty areas enables the top management to make a calculated decision about the areas of variation with regard to their own ideas and targets. Beside strategic considerations there is also a fundamental economic need for the top management to define the areas of variation. A negative example: A profit-centre produces and sells two products P_1 and P_2 with the sales volume X_{P1} and X_{P2} being the accepted basic targets. In the bottom up top down step an operating profit (area target) of that profit-centre has been negotiated. If the profit-centre has complete freedom in choosing its sets of basic target values (which still meets the planned area target value), X_{P1} or X_{P2} could be assigned a value of zero. The negotiated operating profit would then be achieved by producing and selling only one of the two products.

Once an agreement on area target values is reached between top management and executing departments and once the area variation are established by top management, the planning procedure is finished and the area targets have to be realized.

2.6. Decentralized budgeting ('post confrontation')

While the negotiated objectives are being realized, each AOR has the possibility to assign any numerical values to its basic targets within the given areas of variation. In other words, even after the objectives are agreed upon, the planning is not finished but continues in decentralized budgeting. This marks a fundamental difference of the ITP method from other MBO planning systems.

For example, for an objective of 30 an AOR can choose a set of basic targets of 10+10+10 or 12+10+8, etc. The optimal set of basic targets is calculated by each AOR using its self-contained AOR model. The possibility to define the sets of basic targets to their best advantage has a motivating effect on AOR's.

However, AOR's are not isolated. They are embedded within the corporate cost centre structure and hierarchy. Each variation of numerical values of basic targets affects the amounts of mutual profit-centre transfers and leads to a higher request or release of capacities of interrelated AOR's. Therefore, the degree of variation of basic target values is restricted by the capacities of interrelated AOR's. Because each AOR works with a self-contained AOR model it does not know the occupations of interrelated AOR's. Occupations of all AOR's are part of the global ITP model. Therefore every change of basic target values within decentralized budgeting must be approved by the top management. This guarantees the observance of capacity restrictions of interrelated AOR's.

2.7. Target control

In order to perform the ex post control process, the actual values (as opposed to the negotiated values) of basic variables must be registered. Some actual values can be observed or calculated. Others, such as the total amount of monthly salaries, can be retrieved from other corporate computer systems. They are the parameters of a further model which is used to calculate the actual values of the area targets. In the target control the actual values of the objectives are compared with the negotiated values. The target control takes place on a monthly or quarterly basis. However, the above described planning procedure provides objectives on an annual basis only. The splitting up of the negotiated yearly values of basic targets is done by a procedure that will not be described in this essay.

Each AOR is only responsible for the deviations of planned and actual area target values which result from changes of its own basic target values. No AOR is responsible for deviations produced by value changes of decision parameters or uncontrollable basic variables.

3. The INZPLA system

3.1. Overview

The architecture of the INZPLA planning and control system is based on requirements established by the theory of ITP. A fundamental requirement is that the INZPLA system must be an equation-based system, since the ITP model consists of equations.

The application of an equation based system for budget planning and control has significant advantages. With former cost accounting systems the calculation of top targets and, when simultanious equations occur, the calculation of mutual transfer prices has been rather complicated. This is because former cost accounting systems are no equation based systems. Values of transfer prices, once calculated, have been accepted for monthly or annual periods, ignoring the fact that in the course of a month or a year the actual values of transfer prices usually differ from the calculated values. With the INZPLA system beeing an equation based system, it is much easier to determine top target values and transfer prices. Therefore a set of precise values is available at any time.

As mentioned above, there is the possibility to define objectionfree basic variables. When objectionfree variables occur, negotiation of objectives and optimization are no longer contradictory.

As opposed to other equation based systems, INZPLA is not a further attachment to existing corporate planning systems. It distinguishes itself as a special corporate budgeting and control procedure, based on the ITP theory.

There is another important difference: equation based systems usually work on a highly aggregated level and are therefore used to evaluate aggregated business planning problems (such as the DuPont-system or other management ratio systems). [83] Unlike these systems, INZPLA employs highly disaggregated models to achieve the requirements of a MBO planning process. In that respect the global ITP model presented in exhibit 4 is not representative for INZPLA (it

[83] Reichmann (1990), p. 15 ff.

is considerably simplified). For example, ITP models representing individual firm-accounting systems that have been developed within this research project consist of some ten thousand equations. In the recent time we have been working on reconstructing the model described by Kilger.[84] The Kilger ITP model consists of 38 cost centres, 149 cost units and 11 products. It contains 19864 variables, 3353 of which are basic variables. A printout of the Kilger ITP model would amount up to ca. 1150 pages. The size of a database of another ITP test model, containing some 58000 variables, has turned out to be approximately 500 MB.

3.2. Applied hard- and software

The INZPLA system uses client server architecture of relational database management systems. To develop the INZPLA system the following platform is being employed:

Hardware and operating system: 486 PC network using Windows for Workgroups 3.11 and NOVELL 3.11.

Language interface system: An editor to feed model equations into the system plus a compiler to generate executable libraries (DLL). The compiler processes a non procedural order of equations and encodes simultanities (e.g. the mutual cost centre charge transfers) by using the Gauss Seidel algorithm.

Database (RDBMS): Gupta's SQLBase, Version 5.12.

User interface system: Gupta's SQLWindows 4.01 (object oriented 4GL) to develop all client applications and Borland's PASCAL 7.1 with SQL interface for object oriented methods. MS-EXCEL and Gupta's ReportWindows as report systems.

3.3. The distributed system

INZPLA as a distributed budgeting and control system is spread throughout the organization of a firm. The AOR's use client frontends to work with their self-contained AOR model and independent RDBMS. Each AOR database is a copy of a part of the central RDBMS (storing the global ITP model) and contains all information concerning itself. Mutual updates are performed periodically on an asynchronous basis.

The INZPLA system has the following subsystems:

(1) Control station for the following tasks

---

[84] See Kilger (1988).

- administration of users of the INZPLA system, this includes: entering and deleting of users; relating users to primary and secondary AOR's; granting and revoking user authorizations concerning back- and frontend
- defining the sequence of tasks and a planning calender
- distributing tasks to users
- supervising the execution of tasks.

(2) Specific modules for the following tasks

- creating the ITP model equations
- data entry for values of basic variables
- scenario calculations
- planning procedure
- determination of the uncertainty area
- post confrontation
- reporting.

(3) Various tools to analyze the structure of the ITP model

- tool for graphical analysis of interrelations between AOR's
- tool for generating reduced equations based on the ITP equation model
- tool for graphical analysis of the the syntax-tree of ITP models

Exhibit 8 shows the structure of a disaggregated global ITP model for a decentralized profit-centre budgeting process. This ITP model of a fictitious firm consists of seven AOR's, four primary and three secondary ones.

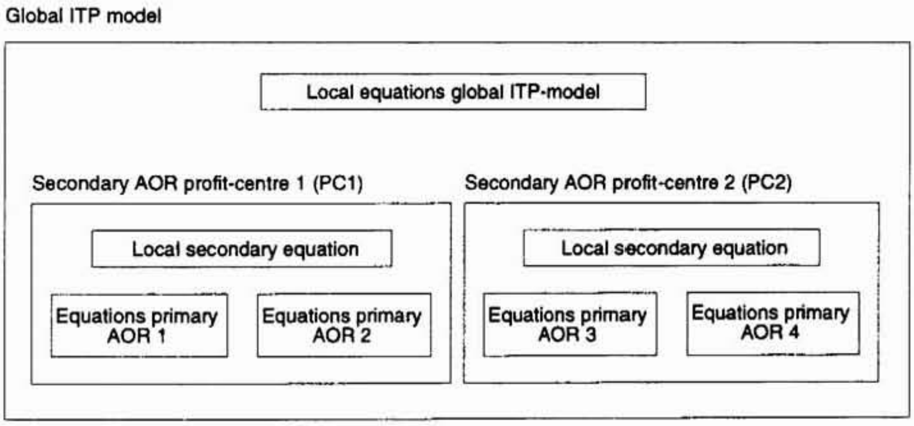

Exhibit 8: Disaggregated global ITP model for decentralized profit-centre budgeting

All seven AOR's form a hierarchy within which the secondary AOR consists of all subordinated AOR's plus a local model equation which aggregates subordinated area targets. Exhibit 9 illustrates a possible configuration of the global ITP model shown in exhibit 8.

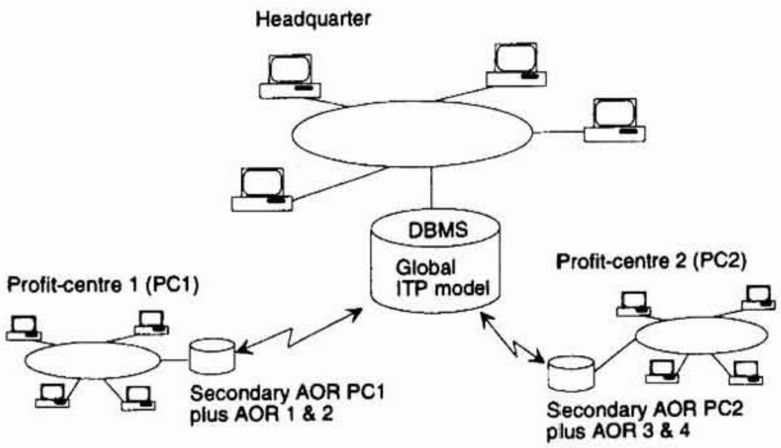

Exhibit 9: Possible configuration of the global ITP model shown in exhibit 8

References

Cyert, R.M.; March, J.G.: A behavioral theory of the firm; Englewood Cliffs 1963.

Kilger, W.: Flexible Plankostenrechnung und Deckungsbeitragsrechnung; Wiesbaden 1988.

Reichmann, T.: Controlling mit Kennzahlen. Grundlagen einer systemgestützten Controlling-Konzeption; München 1990.

Rosenberg, J.: Dictionary of business and management; New York 1978.

Scheer, A.-W.: EDV-orientierte Betriebswirtschaftslehre, Grundlagen für ein effizientes Informationsmanagement; Berlin 1990.

Zwicker, E.: INZPLA - Ein Konzept der computergestützten Unternehmensgesamtplanung, in: W. Lücke (ed.): Betriebswirtschaftliche Steuerungs- und Kontrollprobleme; Wiesbaden 1988, p. 341 ff.