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"Decision Theory and Design in Multi-level hierarchical management structures"

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GENERAL THEME

CONTROL & DECISION MAKING PROBLEMS IN INTEGRATED OPERATIONS IN MANUFACURING & FINANCE

ISSUES:

- **INTEGRATED MANUFACTURING & HIERARCHICAL DECISION MAKING PROBLEMS**
- **FINANCE PROBLEMS & HIERARCHICAL DECISION MAKING**
- **NESTED DECISION & CONTROL PROBLEMS**

- **MULTI-LAYER CONTROL THEORY: GLOBAL CONTROLLABILITY & GLOBAL OBSERVABILITY**

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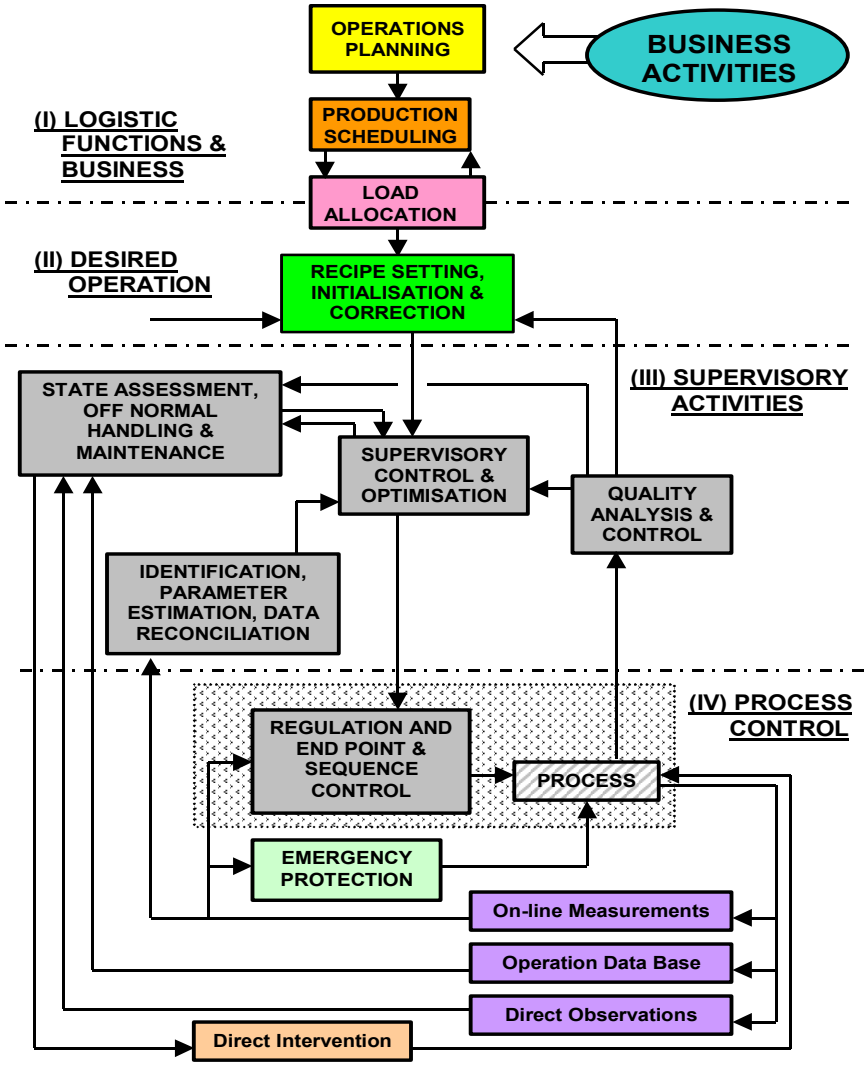
INTEGRATED PROCESS OPERATIONS

Integrated System



Systems Classification:

Discrete, Continuous, Mixed (Batch)

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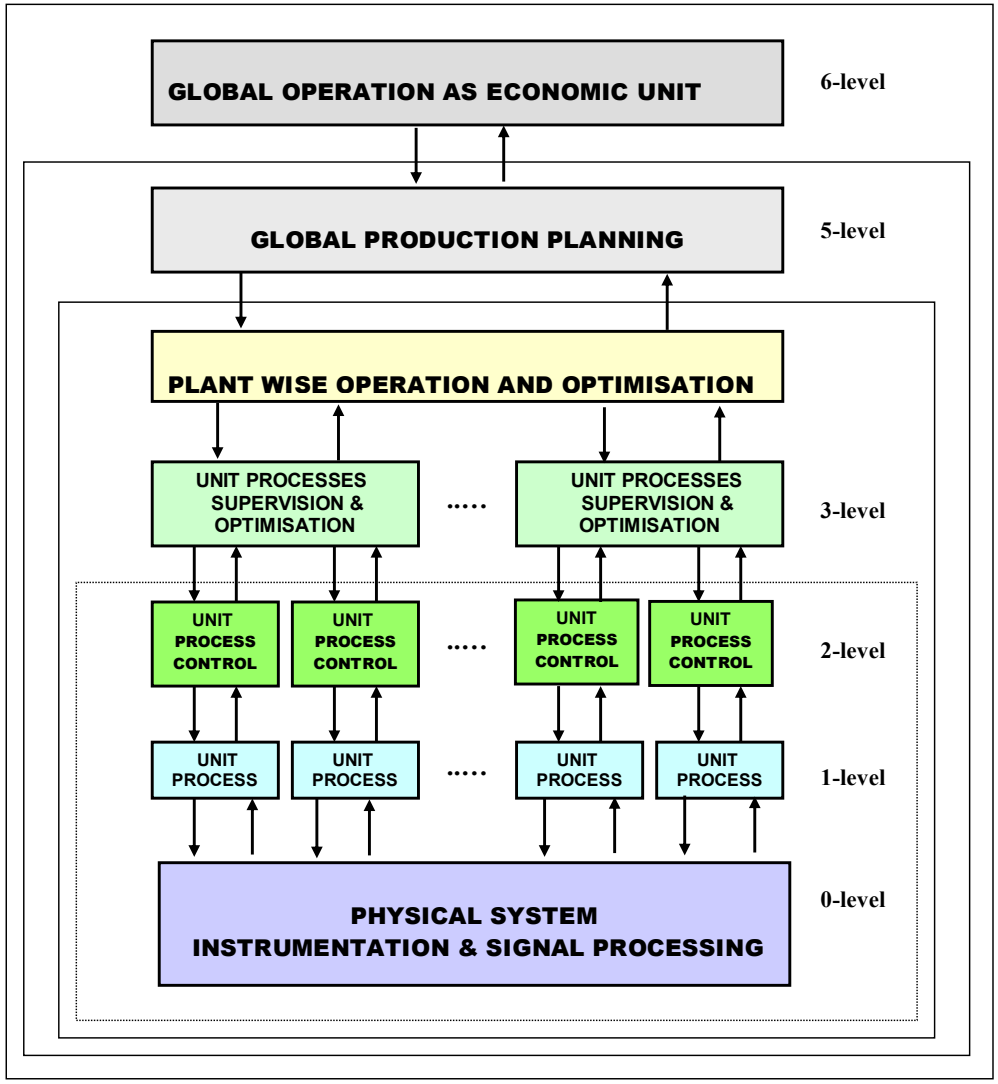
SYSTEMS ORGANISATION

PROBLEM: ORGANISATION OF INFORMATION AND CONTROL-DECISION MAKING STRUCTURES

CLASSIFICATION:

- HIERARCHICAL ORGANISATION
- HETERARCHICAL ORGANISATION
- HOLONIC ORGANISATION
- OTHERS (BIONIC, GENETIC, FRACTAL, RANDOM)

HIERARCHICAL ORGANISATION



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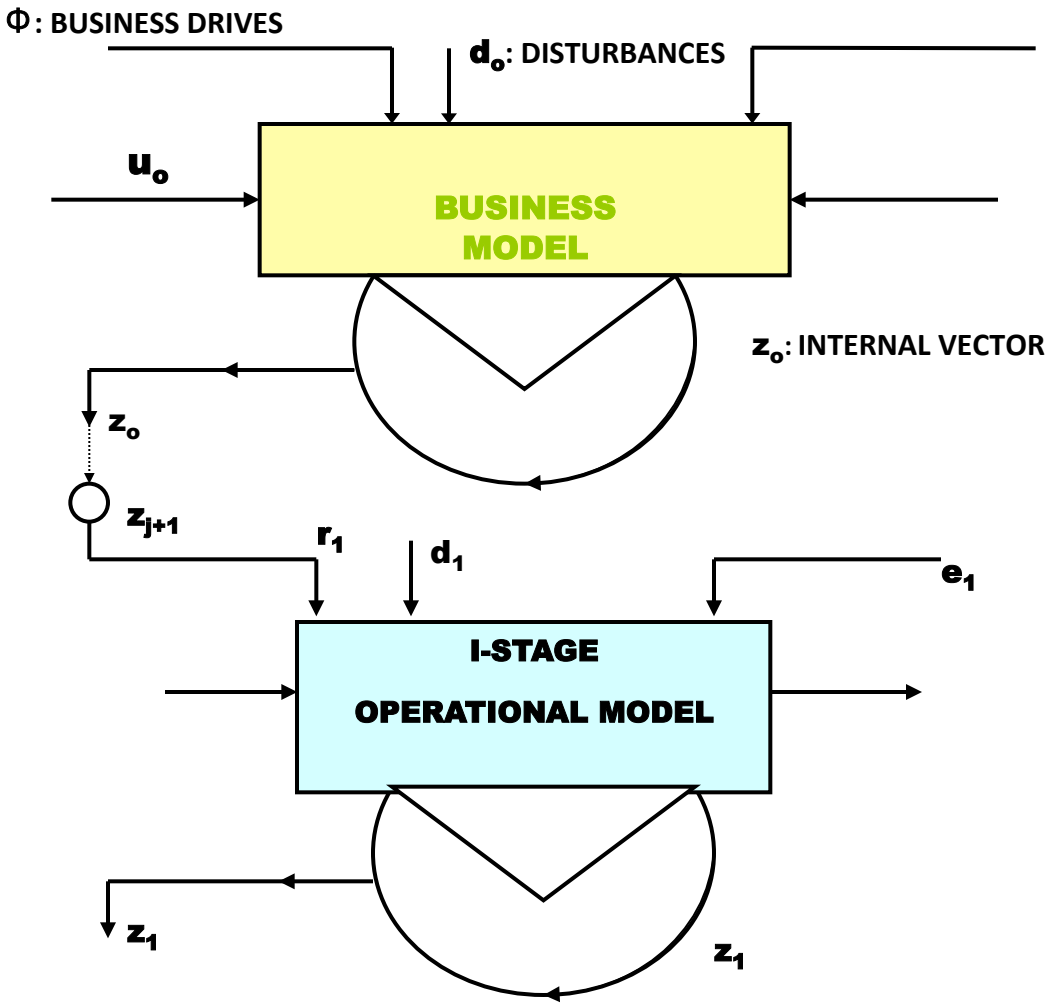
CONTROL ARCHITECTURE IN A HIERARCHICAL ORGANISATION

▲ Integration of Operations in Technological Processes:

- HYBRID SYSTEMS
- "TOP DOWN": GLOBAL CONTROLLABILITY
- "BOTTOM UP"



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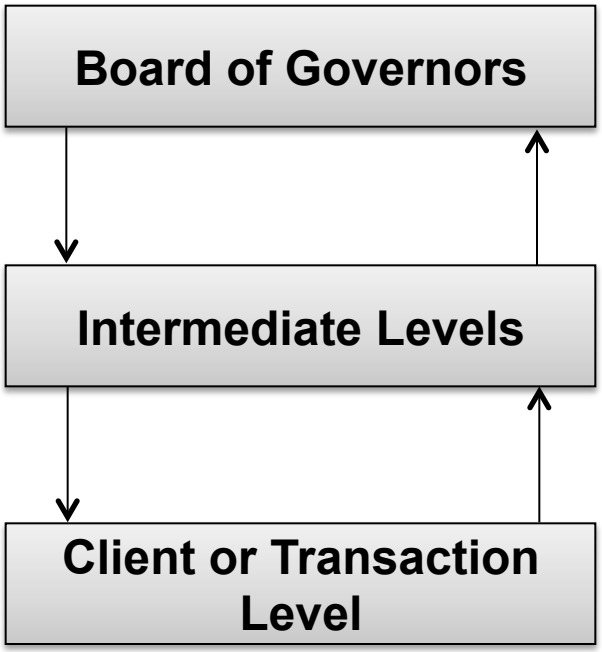
Multi-level Hierarchical Management System In Financial Institution



Macro

Loan Management Problem

Micro

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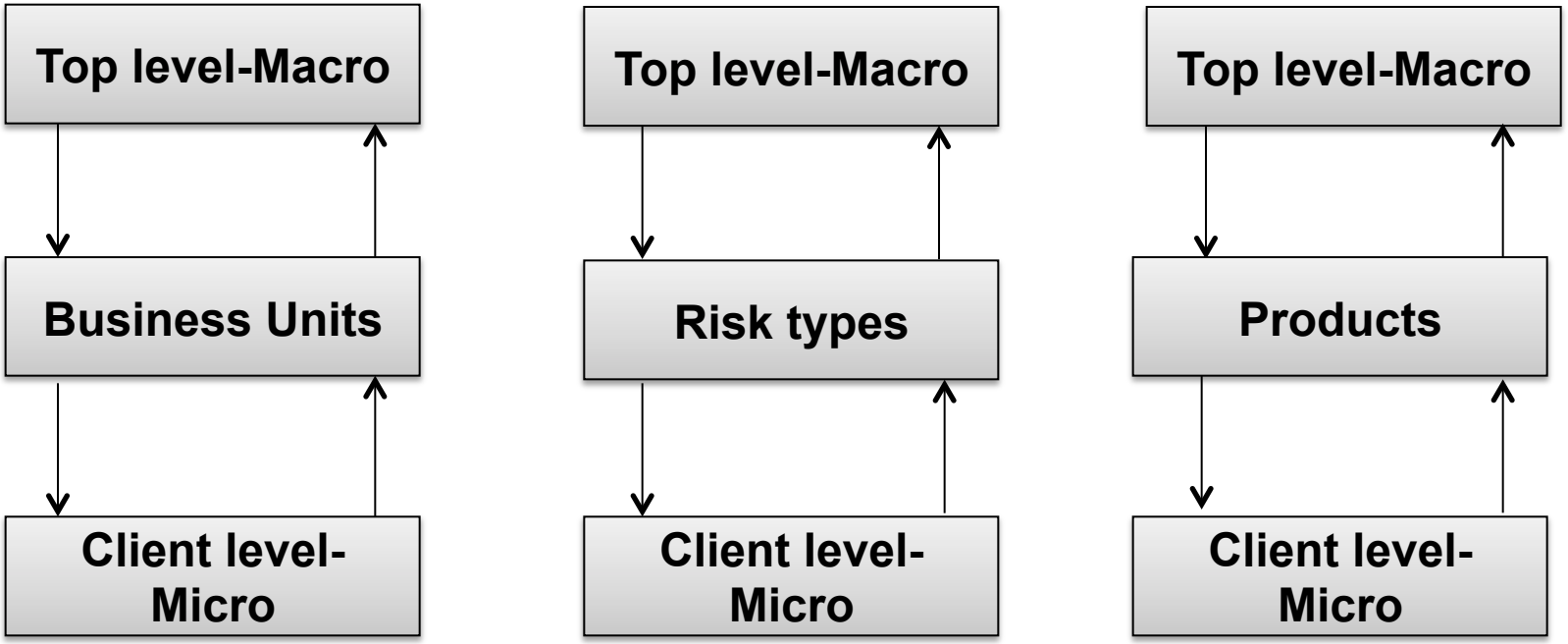
Intermediate Level Views

Intermediate Levels have Different Views



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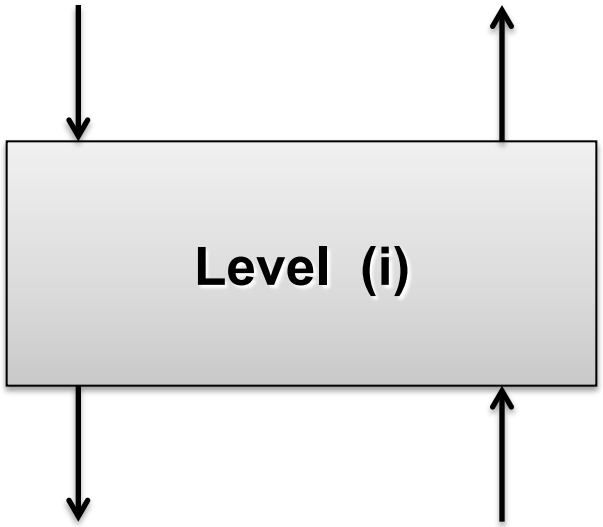
Problem to be Solved in Every Level



Maximise Profit

$$Risk < d$$

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Top-Down Approach

TASKS

1) **The Board sets the *profitability targets* and the *risk appetite* of the institution.**

2) **This is translated to *profitability* and *risk appetite* to the lower levels.**

3) **It is also translated to *credit risk policy* for *loan approval and management* at the lowest client level.**

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Main Tools for Credit Risk Management

- **Rating Systems.**
- **Econometric Models for the calculation of *PD, LGD, EAD.***
- **Database systems keeping the risk information for every client and transaction and being able to aggregate – disaggregate.**
- **Credit Management policies.**
- **Capital Management and allocation systems.**

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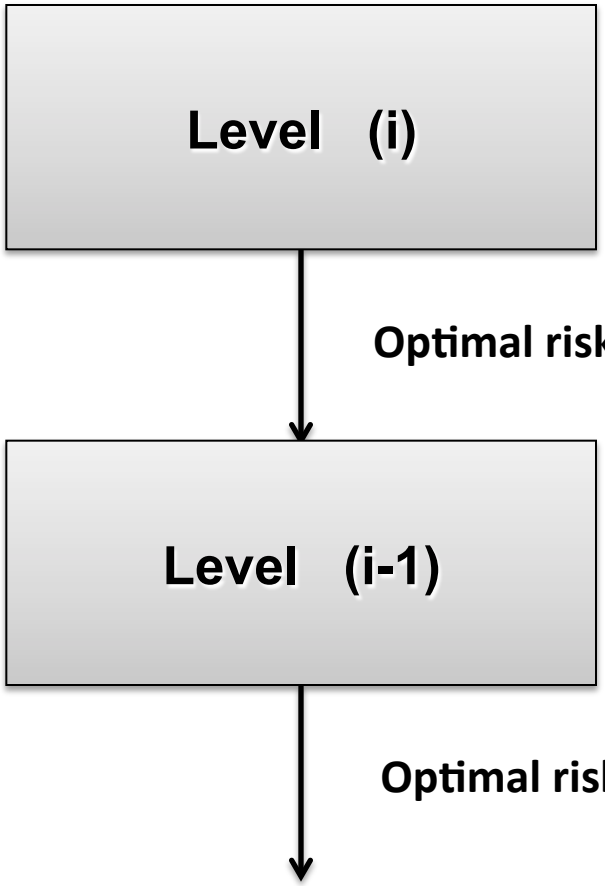
Solution of the Optimisation Problems



Maximise Profit

$$Risk < d$$

Difference Equations of possible different sampling rates/scales

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Models related to the problem

NOTE: In every level, loans are observed in various states according to their repayment status and there is a state vector $\underline{x}$ containing the total balance of loan at every state.

▲The system describing the flows of loans between the various states is described by

$$\underline{x}_{n+1} = A \cdot \underline{x}_n + B \cdot \underline{u}_n$$

where $\underline{u}_n$ is the vector of loans (approved). The output: $\underline{y}_n = C \cdot \underline{x}_n$ describes the target values of risk and profit.

▲ The problem is then to maximise profit and keep risk in acceptable levels. We may also have other algebraic constraints, such as, liquidity, capacity and capital constraints.

▲ The optimal control problem can then be solved at each level using the solution of previous level as input to the next.

▲ The above system is related to the next level system by disaggregation and to the previous by aggregation.

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Outcome of the Optimisation Problem

▲ **Top Level, risk appetite, capital levels for Credit Risk and optimal profit target**

▲ **Bottom Level, types of acceptable clients in terms of rating, exposure limits for every rating, exposure limits for every rating, collateral setting for every type of rating, pricing of loan.**

▲ **Intermediate Level, limits in average PD for every unit or product, limits of exposure for every unit or product. Profitability of every unit or product.**

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CONCLUSIONS

- **Multilevel Hierarchically Nested Systems introduce the need for studying Multilevel Hybrid Systems**
- **Multilevel Hybrid Systems require the introduction of notions of Global Controllability and Global Observability.**
- **The family of Financial, Management Systems is a paradigm of Multilevel Hybrid Systems**
- **Decisions are infiltrated from the top to the bottom level and results of actions are observed from the bottom to the top level**
- **An optimization problem can be defined by optimising profit keeping risk in acceptable levels**
- **This problem can be solved in stages starting from a macro level solution at the top and ending at an analytical or micro level at the bottom.**