PHASES

Information models for industrial environmental control

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1 General information model for full industrial environmental control

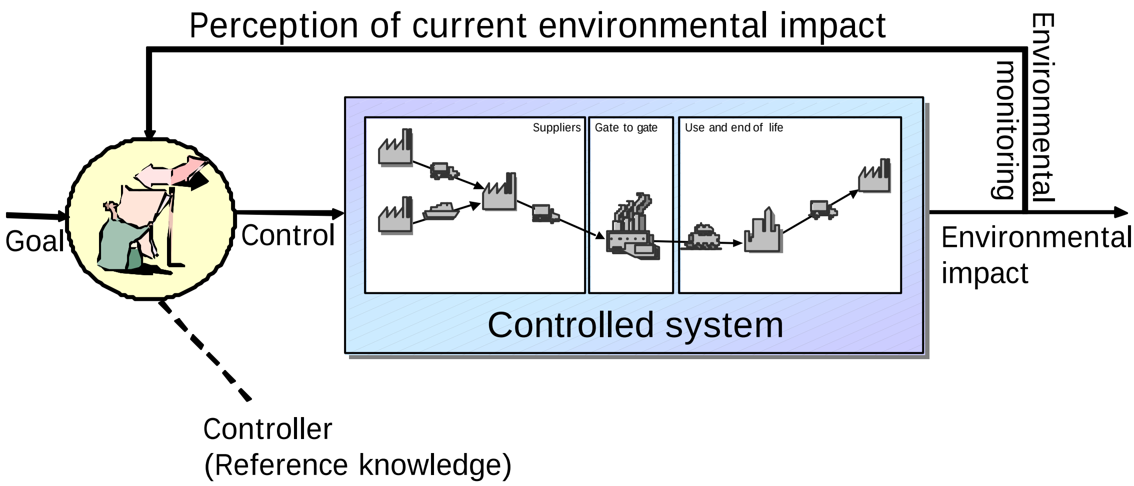


Figure 1. The general information model for an industrial environmental control system.

An industrial environmental control system can be sketched as a general control system: There is an active controller, working with knowledge about which system he controls, an environmental goal for that system, a perceived environmental impact from the system, and with access to additional reference knowledge. The controller gives control signals to the system.

To perceive the environmental impact from the controlled system, the industrial environmental controller requires information from three different types of systems, and the relations between these system types. The three different types of systems are

- Technical systems (Controlled system), concerning humaly controlled or created hardware with an activity that physically interferes with the nature.
- Nature systems (combination of Reference knowledge and Environmental monitoring), concerning hardware which is not created or controlled by living people (though it may well have been both created by or controlled by humans earlier in history, or in the future).
- Social systems (combination of Reference knowledge and Environmental monitoring), concerning individuals', groups', or masses' conscious, sub-conscious, consequential or causal social attitudes with a relevance to technical systems effects and impacts on the nature systems.

In figure 2 the three systems are drawn as rectangles, and the relations between the systems are drawn as rombs.

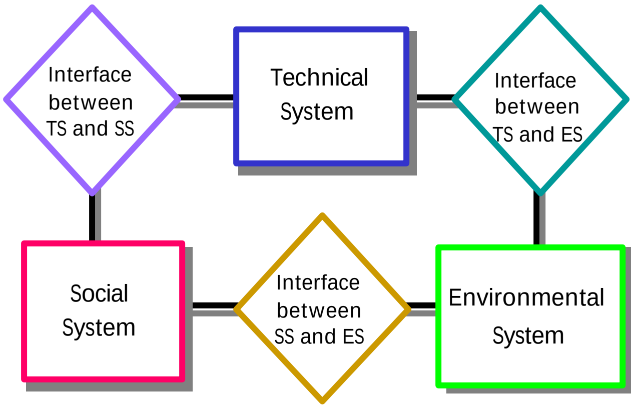
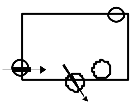


Figure 2. The three systems for which an industrial environmental control system requires information.

Though the controller of an industrial environmental control system never is perfectly rational, he will be in a better position if the information he receives is of high quality, which means that the information well describes what it claims to describe, is understandable to the controller, and is relevant for the control situation. In the following sections models will be presented which describes how such high-quality information can be collected and supplied to the controller.

The managerial level of systems analysis often is sketched at a high level, with a system boundary and some inputs and outputs, sometimes explicitly connected to other high-level system sketches. With such a sketch, most of the systems analytical design-work still remains before a meaningful model of a system is actually at hand. The system boundary represented by a closed rectangle or oval in the sketch needs to be related to the real world. The inputs and outputs to and from the boundary need to be selected in a meaningful way. Quantitative data describing the inputs and outputs need to be measured, statistically treated, and become mathematically related to the system, in the model as well as in the real world. Every choice and selection should be understood, and the understanding needs to be reported, so that in the end, a person being in charge for controlling a system correctly can understand what the model is aimed to express. PHASES, *PHASEs in the design of a model of a System*, is a structure meant to describe all the steps necessary to bridge the gap between the first system model sketch and a full model of the system. In this document three specifications of PHASES are presented, i.e. PHASETS, PHASENS, and PHASESS. They are all specific implementations of the general structure PHASES, which describe how *any* model of a system can be designed.

2 PHASES - PHASEs in the design of a model of a System



PHASES

PHASES, PHASEs in the design of a model of a System, describes how information on an entity representing a parameter of a system (inflow, outflow, internal state, etc.) starts existing at the point where the entity is defined, then quantified, transformed through analytical treatment, and finally reported. The term *phase* refers to that there are a distinct number of intellectual work-phases through which this information management takes place. Each work-phase in itself has an indefinite number of variants. The model does not cover them.

PHASES have six distinct phases, ranging from 0 to 5 (see figure 3). Each phase makes use of information from the earlier phase and delivers to the next. At each phase the information is more and more aggregated, describing a larger domain of the system. In a sound information system the aggregation from 0 to 5 is preceded by the requirement for a report, entering the model at phase 5. From phase 5 a requirement is forwarded to phase 4 etc., until phase 0 is reached. PHASES describes how a reply to such a requirement is communicated upwards through an information system.

At phase 0 an entity is defined, for which quantitative information is to be retrieved. This is the most important task of the model, both since data passed upwards through the model is based on this definition and is understood on the premises of this definition, and because the definition as such requires an overview of the system for which the entity should be related.

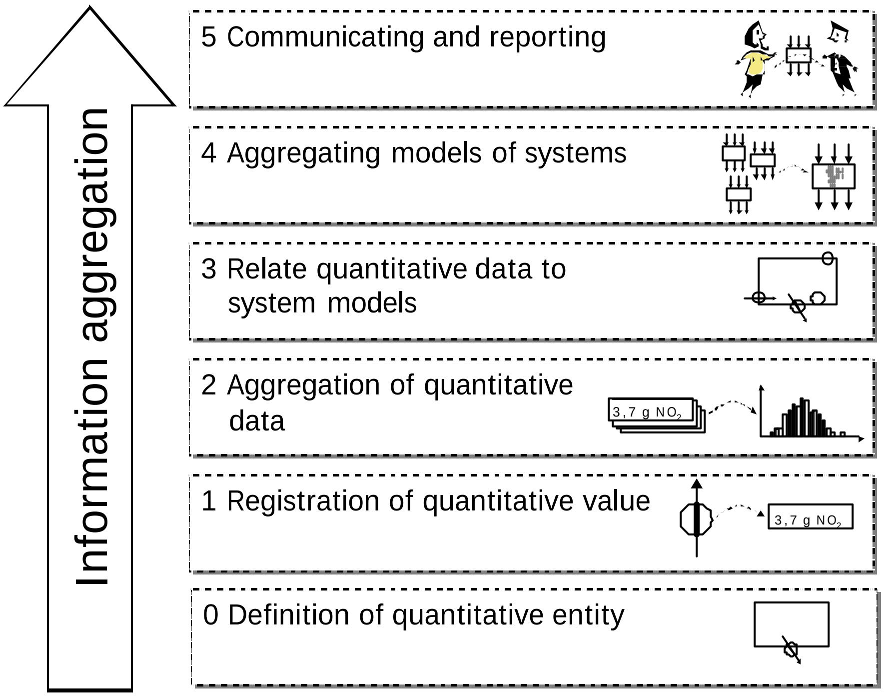


Figure 3. PHASES - PHASEs in the design of a model of a System.

At phase 1 a quantitative data item is sampled, based on the description of the quantitative entity defined at phase 0.

At phase 2 a number of quantitative samples are statistically treated to form an aggregated quantitative value of some kind.

At phase 3 a number of aggregated quantitative values are related to a model of the system.

At phase 4 a number of models of systems are aggregated, either by constructing a higher-level system model from system model components, or by mathematical summation of a number of system models.

At phase 5 the result of a phase is communicated to the one requiring the report. Note: phase 5 takes place between each phase 0 to 4, as well as after phase 4.

2.1 PHASETS - PHASEs in the design of a model of a Technical System

PHASETS

PHASETS refers to information required for the inventory as described in the standard ISO 14041 and to the environmental management as described in ISO 14001, to environmental performance indicators as described in ISO 14031, etc.

PHASETS, *PHASEs in the design of a model of a Technical System*, is a specification of the PHASES model. PHASETS describes how e.g. information systems for industrial production plants, environmental supply-chain data, and information for LCA-studies can be managed so that they allow for environmental control systems according to the information model for industrial environmental control described in section 1. PHASETS describes an ideal data quality level, by allowing a qualitative measurement of transparency-depth, an overall structure for a corporate environmental information system, a quality assurance system for environmentally related performance data etc. PHASETS is described in detail in the paper Carlson, Pålsson; Industrial environmental information management for technical systems, Journal of Cleaner Production, 9 (2001) 429-435.

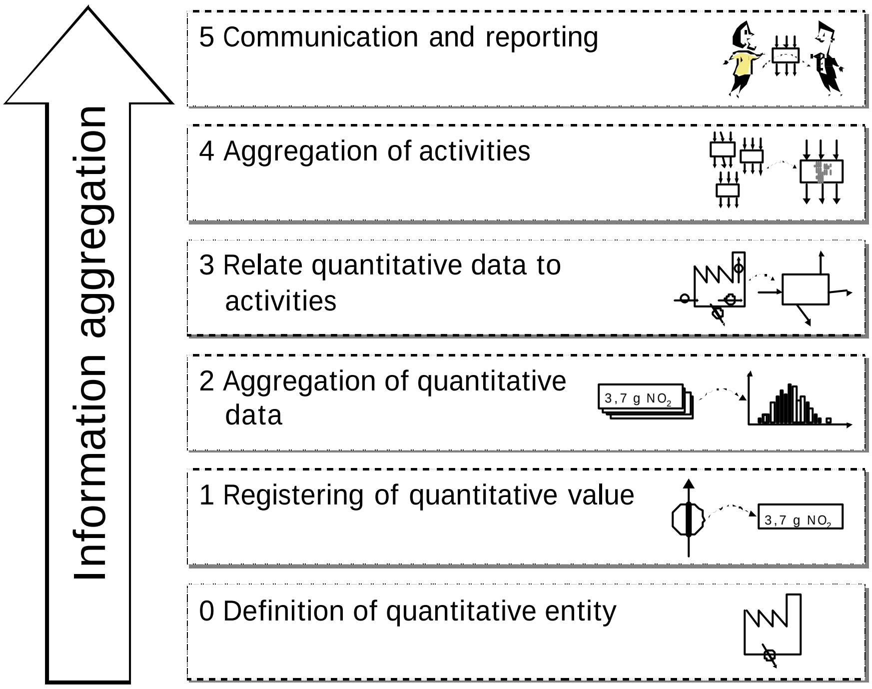
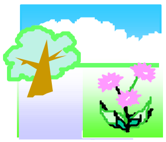


Figure 4. PHASETS, PHASEs in the design of a model of a Technical System

2.2 PHASENS - PHASEs in the design of a model of a Nature System



PHASENS

PHASENS refers to information required for characterization, as described in the standard ISO 14042. It is of course also a strong background to the selection of entities in phase 0 in the PHASETS model.

PHASENS, *PHASEs in the design of a model of a Nature System*, is a specification of the PHASES model. PHASENS describes how information about changes in systems not being controlled by humans are communicated and analyzed, from definition of an environmental category indicator up to final reporting. Management of information about changes in the nature in accordance with PHASENS gives information quality assurance and enables compatibility with data in the PHASETS model.

Phase 0 in PHASENS requires strong rigidity regarding the application of environmental measurement techniques by explicitly requiring *which* natural environmental system and which quantitative entity a piece of information about an environmental change addresses. Explicit declaration of nature systems and entities is valuable when comparing changes in e.g. different time-scales, different geographical scales, or different biological habitats within the same geographical and temporal scales.

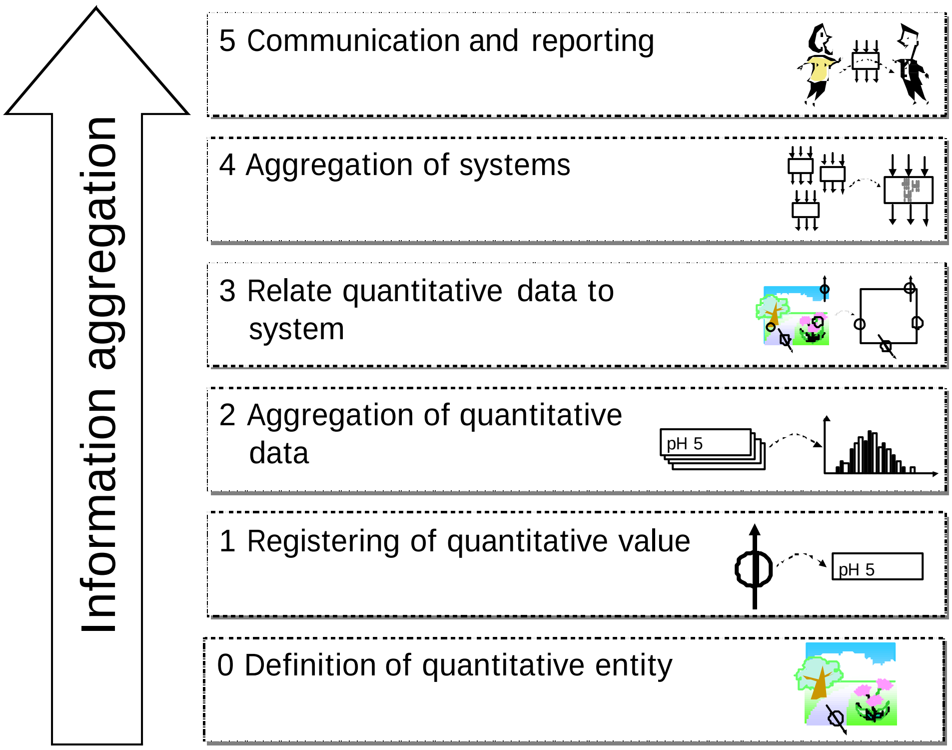


Figure 5. PHASENS, PHASEs in the design of a model of a Nature System

2.3 PHASESS - PHASEs in the design of a model of a Social System

PHASESS

PHASESS refers to information required for weighting, as described in the standard ISO 14042. It is of course also a strong background to the selection of entities in phase 0 in both the PHASETS and the PHASENS models.

PHASESS, *PHASEs in the design of a model of a Social System*, is a specification of the PHASES model. A social system is a set of human individuals, a statistical population, selected because of an interest in this population's e.g. actions, evaluations, values, or attitudes regarding changes in the natural environment (described as prescribed by PHASENS) or the goods supplied from a technical system (described as prescribed by PHASETS). Examples of populations relevant for industrial environmental control are demographically selected potential markets, stakeholders of different kinds, political organizations and authoritative experts. PHASESS describes how information about how the population are selected, how the information about them were acquired, what information was acquired, etc. up to final reporting.

Management of information about populations' values, attitudes, etc. in accordance with PHASESS gives information quality assurance and enables compatibility with data in both the PHASETS and the PHASENS models.

Phase 0 in PHASESS requires strong rigidity regarding the application of sociological methodology by requiring an explicit consciousness of *which* social system and which information about attitudes, values, etc. it addresses. Explicit declaration of social systems boundaries is valuable when comparing e.g. different time-scales, different geographical scales, or different demographics within the same geographical and temporal scales.

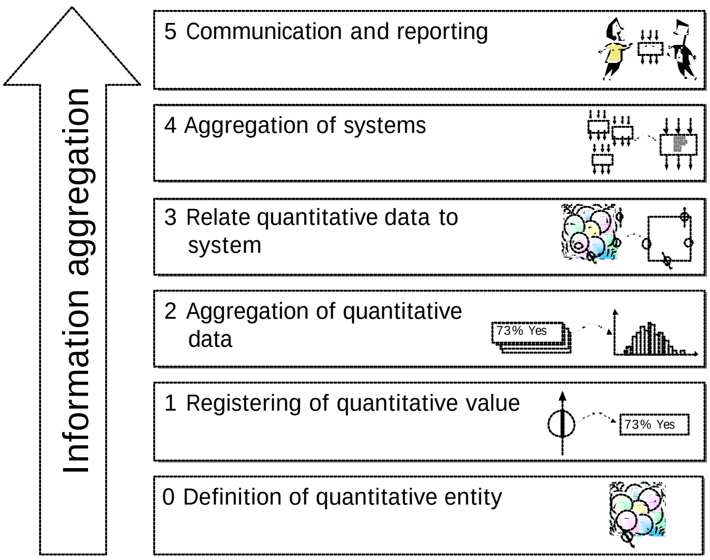


Figure 6. PHASENS, PHASEs in the design of a model of a Social System

3 Applications of the three specifications of PHASES

In section 1 the general control model was introduced in figure 1. In order to control the environmental performance of an industrial system, the controller is in need of the best available information, and the three models PHASETS, PHASENS, and PHASESS describe an ideal quality for the information for all three system types described in figure 2.

In manual information systems it would be tedious for any controller to have access to all the information generated with these models, but with computer based information systems the data management in itself is not a problem. It is not only possible, but also quite simple to manage all information, from phase 0 up to phase 5 in all three models. The database structure SPINE, *Sustainable Product Information Network for the Environment*, is designed to manage the structure described in figure 2, so that the correct information can be related with each other within the information system. So, the full application of PHASETS, PHASENS, and PHASENS, together with a SPINE based database system is the basis for a full industrial environmental control. The general architecture of such a system is sketched in figure 7. Note that the architecture exactly matches the general PHASES model, while also integrated with organizational tasks.

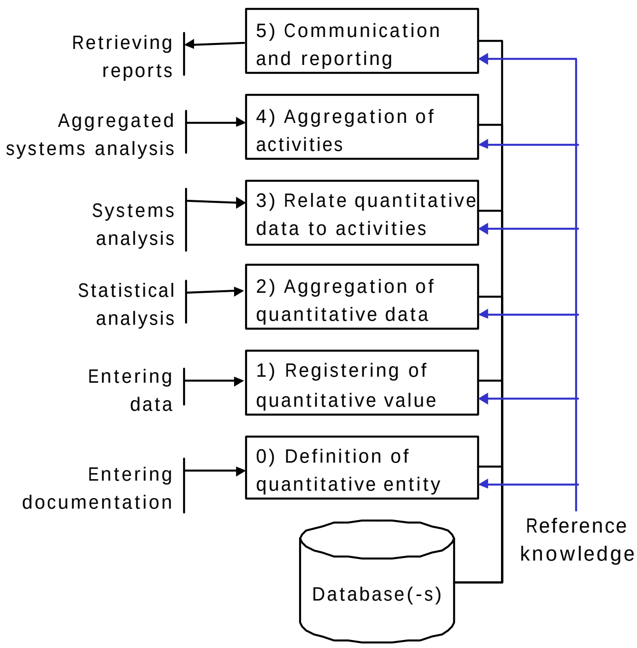


Figure 7. General architecture for an information system for full industrial environmental control.