Gianni Grasso
Ministero Attività Produttive
Direzione Sviluppo e Competitività
SSIP - Napoli
SSIP@iol.it

"UNIT CONCEPTS" FOR "TECHNOLOGICAL GOOD PRACTICE"

Basic "unit concepts" can help us to managing properties of soft materials (bioorganic) in terms of "unit properties". Thus they are available proper tools to formalize and structure technological knowledge and behaviour specifications about these materials, i.e. about their behaviour constraints, regulations and laws. So we can think to focus our attention on an assurance system managing technological practice.

In two previous papers we attempt systematically to describe technical properties of bioorganic materials in terms of *unit properties*, starting from an *unit structures* classification concerning the inside system [1, 2]. In our point of view every technological object in our investigation or technical change was considered as a "system" *S* exposed to a determined "environment" E. The "*S/E* approach" showed a first complexity decoding and applicability in several contexts, such as nanosystems [3]; i.e. in the nano-technology and bio-technology typical contexts, where molecular, supermolecular, colloidal and composite properties were contemporaneously treated as cumulative functional properties of the system considered as a whole.

Now we try to answer to the question: "Can technology practice be codified in a "good practice" or pragmatic flow-chart, as it is for quality or safety?"

Stressing complexity decoding toward the five "unit elements" assembly of the *S/E* description

For a more pragmatic use, the handling of bioorganic characteristics in terms of unit properties could be operatively founded on a managing system of materials and matter concepts conveniently formalized as "*unit concepts*". I.e. concerning *unit interactions* and *unit states* too, signifying respectively any sort of inner system interconnections or external exchanges and all typologies of system behaviour. That is, respectively: 1) chemical or physical bonds, analytical relations quantifying the reciprocal amounts of the *S* subsystems populations, hierarchical sub-systems relations etc. and matter/energy fluxes striking or escaping out from the system, 2) static versus dynamic status. System's properties come off in form of concrete expression either in the form of OUTPUT or circumstantial system answers or in the form of the κ_j system constants or

Table 1 - Explication and differentiation of the system *unit elements*

Unit elements	Classes/categories
actions IN_S ($\int$fluxes J_Z)	Z=transports: Q=heat, m=matter, mv=momentum, n=moles
structures M_k	molecular, colloidal, particled, histologic, macro (phases, components), virtual
interactions I_k	primary/secondary bonds, hierarchical/ quantitative relations
states Ψ_i	dynamic (deterministic/stochastic), static or equilibrium, metastable
properties λ_j ($\equiv OUT_j$, κ_j)	contingent outlets or answers OUT, system parameters κ
system laws L_j, L_{jk}	IN/OUT balance, equilibrium, kinetic and property/structure relations

proportionality material-coefficients that fit the system-laws.

Therefore we can speak about five *unit elements* or fundamental *unit variables* of the system involved in the *S/E* general interaction mechanism based on our previous analogic model of material body (Figure 1). The rough classification is summarized in Table 1. The idea is naturally coming out from the Systems Theory, if we consider that the basic characteristics of every system are indeed their structure, their inner and IN-OUT connections and their behaviour [4].

A sixth unitary concept links ideally the previous ones, i.e. the *unit system-laws*. These latter are symbolic models put in form of OUTPUT-INPUT quantitative relationships, numerical ratios of populations of some *S* sub-systems at equilibrium, time decaying or rising expressions concerning some *S* sub-systems populations subject to dynamical change or intensities of related properties and finally analytical functions relating systems properties and proper sub-systems structure-parameters by means of the so-called system-constants. Typical examples related to a similar classification are, respectively: I=TI_o optical transmission law, $K=N_B/N_A$ equilibrium laws, $N_A=N^o_A\ e^{-kt}$ or $N_B=N^o_A(1 - e^{-kt})$ integrated kinetics laws and $p_A=p^o_A\ x_B$ Raoult law, where T, K, k and $p°_A$ are the κ_j system constants.

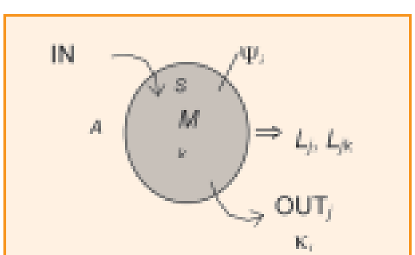


Figure 1 - System-Environment interaction and analogic model of the "body-system" with the critical elements of the interaction and systemic status, or interaction mechanism: IN$\equiv J_Z$=actions/causes of change, M_k, I_k=structures, interactions, Ψ_i=states, L_j, L_{jk}=system laws, OUT_j, κ_j=answers/effects, properties

Unit concepts show the main advantage of plenty independence from their particular context, i.e. from each particular material matrix where they could be considered. They are the fundamental and ubiquitous symbolic or iconic models that are recurrent in the scientific description of all technological events.

Management perspectives

Therefore our target is now how address better the mix of unit concepts toward a "problem solving" tool. Following our pictorial scheme of interaction mechanism of Figure 1, the OUT system answers can be formally related to the IN external stimuli, according to the general analytical function:

$$OUT_S = f[IN_S, (M_k\ ...,\ I_k\ ...,\ \Psi_{ik}\ ...)]_{T,P,n} \qquad \text{at constant } T, P, n$$

where *S* and *k* subscripts refer respectively to the whole system and some of its emerging critical sub-systems. Obviously a *T, P, n* thermodynamical control is expected.

Firstly we note that starting from our "5 + 1" unit system-variables as elementary or fundamental terms of technical language, we can now better and concisely define our unit properties concept according to the recursive syntactical sequence of the "IN_S, M_k-I_k, Ψ_{ik}" logic scheme (Table 2, reported examples of six technological properties reduced in unit terms; i.e. translated from terms *j* generically expressed into quantitative λ_j-λ_{jk} parameters or concepts quantifying OUT_S). Thus, for example, the first of the considered properties, the freezing point, can be simply expressed in a codified synthetic form coming from the following full expression of common language:

"The freezing point of a fruit and vegetable (=*j*) is a property observed in consequence of a thermal transport induced by an environment ΔT thermal lowering (=IN_S, transport of Q) and related to the inner liquid matter fraction or its physiological solution (=M_k), whose molecular or electrolytic components are subject to secondary interactions (=I_k) acting a short/long range. This property is quantitatively signified, in equilibrium status (=Ψ_{ik}), by the eutectic point T_E in a binary water-components phases dia-

Table 2 - Exemplification of some material system unit properties, or properties codified in "unit terms"

		Science driven approach - system variables				
	Property j (general proposition)	Actions IN_{ij} (J_Z [1])	Structures M_k	Interactions I_h [2]	States Ψ_l	Quantified property λ_j-λ_{jk} (OUT$_j$, κ_j)
Technology oriented assembly	Freezing point	transport of Q	liquid solution	secondary (solvatation, crystallization)	equilibrium	cryoscopic lowering ΔT_c
	Growing rancid	transport of m/n	critical components	primary (chemism) secondary (diffusion)	dynamic	chemical kinetic constant k_r
	Electrical conductibility	transport of q	all	primary/secondary (electrons motion in bonds)	dynamic	conductibility constant k_q
	Viscosity	transport of mv	all	secondary (internal friction)	dynamic	viscosity constant η
	Sterilization	transport of Q	continuum microorganisms critical components	primary/secondary (thermal motion in bonds) secondary (enzymes denaturation) functional, physiological	dynamic	conductibility constant k_Q microbial kinetic constants k_S process time t_p
	Toxicity	transport of m/n	critical components cells organism	secondary/primary (specific interactions, chemism, bio-chemism) secondary (diffusion)	dynamic	lethal dose LD_{50}

[1] Z=transported entity: Q=heat, m=matter, n=moles, q=electric charge, mv=momentum

[2] secondary chemical bonds (hydrogen etc.) or primary, hierarchical/ quantitative relations among the various structures

Knowledge Management deals with the problem to provide people with knowledge necessary to solve their problem or archiving, retrieving and re-interpreting information to be used by others, or provided by others, respectively; see R. Riedl, Some critical remarks in favour of IT-based Knowledge Management, *UPgrade - The European Online Magazine for the IT Professional,* 2002, **3**(1), 45. More generally it involves the capture, organisation, classification and dissemination of knowledge; see R. Cobos, J. A. Esquivel, X. Alamàn, IT tools for Knowledge Management: a study of the current situation, *UPgrade - The European Online Magazine for the IT Professional*, 2002, **3**(1), 60.

gram or by the cryoscopic lowering ΔT_c. This latter is specified by the corresponding $\Delta T_c = k_c m$ law ($=L_{jk}$), where the cryoscopic constant k_c ($= \kappa_j$, i.e. λ_j) and the molal concentration m are both characteristics of the system"

The same "5 + 1" unit elements assembly is a knowledge-skill well suitable for classifying, ordering, structuring and codifying the common scientific knowledge concerning the fundamentals of Physics, Chemistry, Microbiology and Engineering Science involved in every technical description [3]; i.e. in the technological handling of scientific concepts. This action is a part of the field of the new emerging Knowledge Management [5]. Table 2 resembles a real *deployment matrix* of technological properties of the transformed system (properties versus their descriptive, scientific variables), following the matrix scheme of the *Quality Function Deployment* methodology.

Thus we can suggest a "good technological practice" system as a real managing system (Figure 2) that operates on a given R&D technical problem by the well-known six fundamental actions steps of the *Plan Do Check Act* cycle [6]. These are typical of all common quality or safety assurance systems: 1) define in our conventional modelling language the "reference framework" of the general scientific and technological knowledge and regulations; 2) focus specific attention on the given material system and problem; 3) hypotize the proper specific *S/E* model, identifying for example the critical M_k sub-structure or sub-structures involved in the problem (see Figure 2 in [2]); 4) design and carry-out the experiment about the system change; 5) verify the exactness of the supposed model, i.e. the conformity or not the obtained results versus the expected ones (e. g. comparing the stated and measured properties or the theoretical and experimental laws); 6) recycle eventually every next tentative if the previous was fallen.

In this context the "5 + 1" approach is the device allows to

ABSTRACT

"Concetti unitari" per una "buona prassi tecnologica"

Lo studio verifica la possibilità di estensione dei "metodi della Qualità" nell'ambito delle attività di R&S, attraverso un modello di interazione processo-prodotto basato sulla definizione in termini "unitari" delle "azioni" e delle "strutture", "interazioni", "stati" e "proprietà" del sistema quali variabili d' interazione. Queste, nella forma di matrice di correlazione proprietà-variabili o "tabellazione QFD", sono utilizzabili per la codificazione del quadro di riferimento della conoscenza tecnica del sistema, all' interno di un Sistema Gestionale per l' assicurazione di una "buona prassi tecnologica".

codify the matter behaviour as the natural physical or biological constraints and laws constituting the formal, technical regulations and specification of the specific systems subjected to management. We can properly speak of a "5 + 1" criterion as of a standard to classify technical contexts in a structured data-base form (see Table 2) suitable for Information Technologies too.

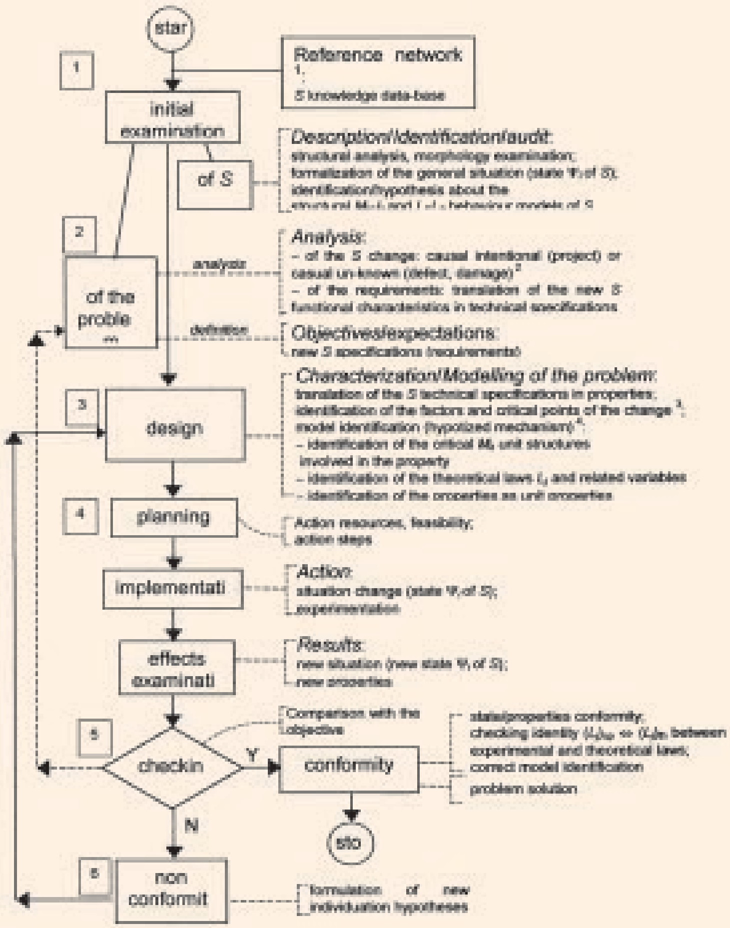
Conclusion

System Theory aids to convert and codify in symbolic language each previous scientific and technical information, in order to "standardize" and "modellize" the reference framework or status of art of the present technical knowledge (knowledge restructuring). This corresponds to the normative or reference context of our "assurance system", that is given, in the specific case of technology, by the natural laws and limitations of the physical and biological behaviour. The by-model organization criterion assures flexibility, experience recycling and aptitude to handling and communication in the continuously growing knowledge.
After that we proceed simply to examine, modify and verify the changed system according to the usual managing systems procedures.
The "hard core" of such "assurance system" is just how to state and formalize in the best the reference context and the methods involved in the successive management actions. The unit properties approach revealed useful in order to try to overcome the first of these problems.
Thus the mix of the basic principles of the System Theory applied to the Materials Science and Technology and the methods of the Managing Systems and Knowledge Management, seems to carry-out the technical and management contents suggesting an embryonal form of a technological managing system.

References

[1] G. Grasso, *Chimica e Industria*, 2002, **84**(1), 43. See Table 2.
[2] G. Grasso, *Chimica e Industria*, 2003, **85**(5), 34. See Table 1.
[3] G. Grasso, Tecnologie dei Materiali e Prodotti agroindustriali, CD-ROM, Ferraro, Napoli, 2004.
[4] F.E. Emery *et al.*, La teoria dei sistemi. Presupposti, caratteristiche e sviluppi del pensiero sistemico, 6ª Ed., FrancoAngeli, Milano, 2001.
[5] P.H. Hendriks, *Knowledge-based systems*, 1999, **12**, 159.
[6] G. Grasso, *Qualità*, 2004, **34**(6), 53.

Figure 2 - Flow-chart of managing system or "good practice" technical protocol



[1] General technical knowledge and natural systems regulations properly modellized, e.g. according to the "*S/E* approach" or other criteria; knowledge on the structure of the *S* material systems (several M_k, I_k unit structures and interactions), their potential interactions with the environment E (unit operations related to the transport actions IN≡J_Z, I_Φ; i.e. to the fluxes and fields intensities at the *S/E* boundary) and the various λ_j or λ_{jk} (=OUT$_j$, κ_j) unit properties and system laws (L_j, L_{jk}).
[2] If we introduce proper modifications, discussion can be applied either as a causal prefixed case (project) or a casual and un-known one (defect) with consequent remediation actions.
[3] *S/E* (System/Environment) correlation, of the considered system property with the S boundary conditions and its composition, or $\lambda_j=\lambda_j(T, P, n, \ldots)$. Visualization of the inputs IN as boundary fluxes J_Z or field intensities I_Φ (unit transports). General knowledge of the variables involved in the change at each level: of the state (T, P, n, …), in entry IN and specified as unit transports J_Z (process variables).
[4] Recognition of the considered case in the set of the models of the reference framework. Formulation of the identification hypothesis, or formalization of the inquired OUT property (technological, functional or environmental) in a proper model, such as unit property.