On some Aspects of TRIZ Flow Analysis

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Summary

Some aspects on the concept of a flow and Flow Analysis are discussed, which emerged from considerations of flows in computer science and from the component concept in Component Based Software Engineering.

Basic concepts are developed, in particular the difference between the structural and operational concept of a system, as elaborated by Shchedrovitsky, for example.

In the presentation the concepts can only be sketched. An example of flows of water and dirt in a dishwasher, which was analysed based on Flow Analysis by Uwe Schaumann, is considered in more detail.

Due to time constraints, the relations to computer science cannot be touched, which are presented in more detail in the paper.

TRIZ Flow Analysis – A First Approximation

Work by Lyubomirsky, Logvinov, Lebedyev after 2000

- Flow Development Patterns by Lyubomirsky 2006
  - http://wumm.uni-leipzig.de/flowdevpat.php
- The strong parallels to the well-developed TRIZ concepts of Functional Analysis are emphasised.

What is a flow?

- Russian "potok" and English translations: flow, flux, stream, ...
- Do the parts source, sink, flow, carrier and channel belong to every flow?
- Does a control flow in computer science have a carrier or a channel?

Flows and Systemic Throughput

Flow analysis is essentially concerned with throughput issues.

- Altshuller's development law of minimal energy conductivity.
- A technical system as Open System requires a quantitatively and qualitatively determined *throughput of energy*, *substance and information* for viability.

The fundamental contradiction of any systemic approach – *the decomposition of the indecomposable*. This indecomposability does not end at the boundaries of the system.

Flows and Systemic Throughput

Shchedrovitsky distinguishes system concepts of first and second kind, which build on each other.

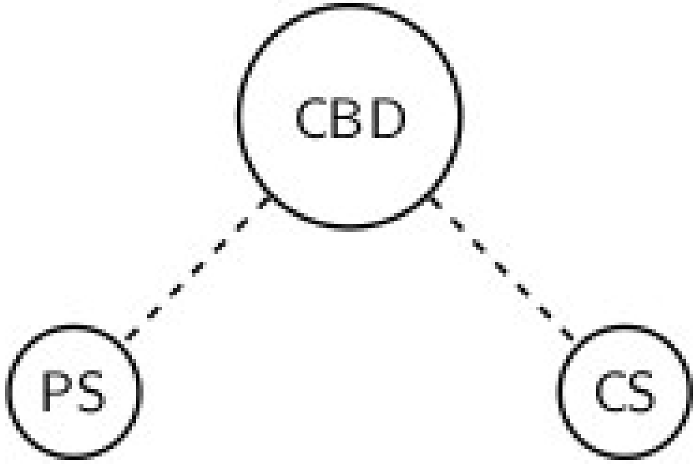
He emphasises: The systemic-structural approach (of a system of first kind) does not capture processes as such.

It are precisely these questions of a complex descriptive structure of systems that have to be addressed in flow analysis.

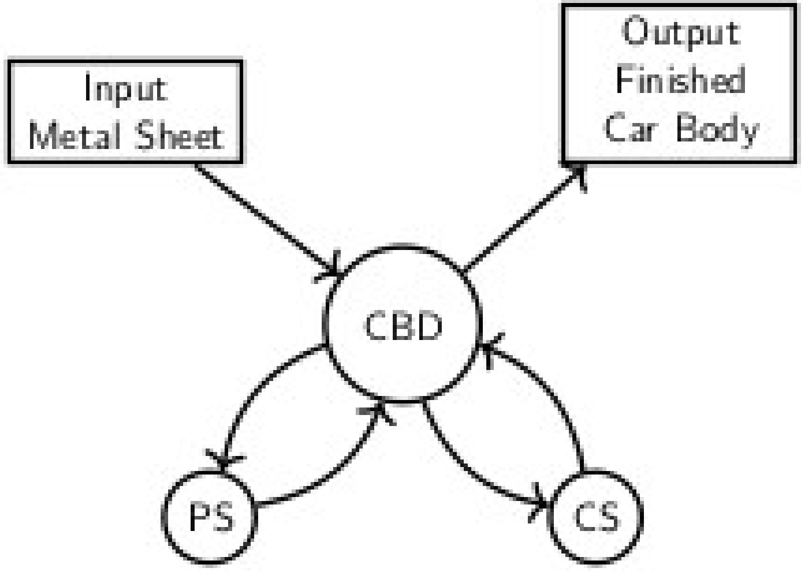
In this respect Flow Analysis is fundamentally different from Functional Analysis and much closer to Process Analysis.

Flow of Workpieces

A technical system (TS) consists of a number of technical components (TC), which – in the simplest case – transform the object (workpiece) several times in a well-defined sequence of operations until it becomes the useful product.



Structural Organisation



Operational Organisation

Flow of Workpieces

The *flow of workpieces* through this chain of functions leads to a sequence of targeted state changes of the workpiece.

For this to happen, however, the workpiece must fit a well-defined *specification* at the input of each TC as well as at its output, because the output of a TC on the path of the flow of workpieces is followed by the input of the next TC.

This structure is typical for a simple assembly line system, showing that the flow of workpieces, as the prototype of any “useful” flow, is *orthogonal* to the energy flow to the tool which provokes these state changes of the workpiece.

Schaumann’s Example

Are there also functions assigned to the flow of workpieces?

Schaumann records this functional aspect of flows in a separate column with heading *function type* and values *transport function*, *correction function* and *production function*.

However, this subdivision does not seem to be very helpful in his modelling, since all three function types are always present in the depicted parts of the tables.

Nevertheless, such a *Flow Function Analysis* based on a clear classification of flow function types seems to be quite useful in order better to understand the difference and interplay between a *flow as an active tool* and a *flow as a simple means of transport of passive workpieces*.

Schaumann’s Example

The *transport function* seems to be one of the basic functions of flows.

Lebedyev proposes a distinction between the *carrier* and the *carried* and tries to unite both under the term *flow*.

But the conveyor belt in an assembly line production as a carrier of the workpieces has clearly other independent functions as a TC – in addition to the actual transport function, the speed of the conveyor belt determines the work rhythms and also the reaction possibilities in problematic situations – triggering the "red button" stops the conveyor belt and thus also the flow of workpieces in order to concentrate on eliminating a problem (as provided for in the Toyota Production Model, for example).

Schaumann’s Example

In Schaumann’s example the water flow fulfils its transport function by transporting the "workpiece" dirt from the plates to the collection sieves.

In Schaumann's flow analysis, the water flow is modelled as a carrier of three other flows (coarse, fine and micro dirt).

We are dealing with a situation similar to that of the conveyor belt: the carrier as flow is meaningless ("parasitic") without the carried material, but on the other hand, as a mixture of carrier and carried material, it may change the properties and thus the behaviour of the flow.

Hence the properties of the transport function of the flow do not result solely from those of the carrier.

Altshuller's Development Laws and Open Systems

Altshuller's Law of minimum energy conductivity of a system may be read as requirement to supply its components with an energy throughput to "awake" them and keep them "alive".

This is a fundamental constitutive principle of Open Systems in general, especially of living and social systems driven by metabolism. A specific internal structure only gets formed and maintained if a defined throughput is guaranteed.

The structuring effect of the energy throughput on a component depends in most cases also very strongly on *qualitative* parameters of the energy flow. Both the type and composition of the energy and the supply regime play an important role, for example, in the technical exploitation of resonances and dissonances.

Altshuller's Development Laws and Open Systems

This brings a number of other Altshuller's development laws into the focus of consideration – the *Law of Adjusting the Rhythms* (nowadays also called *Trend of Increasing Coordination*), the *Law of Uneven Development of System Components* and the *Law of Transition to the Supersystem*.

We see that the effects of several of Altshuller's laws meet in a reasonably comprehensively understood Flow Analysis.

Flows and Transmission

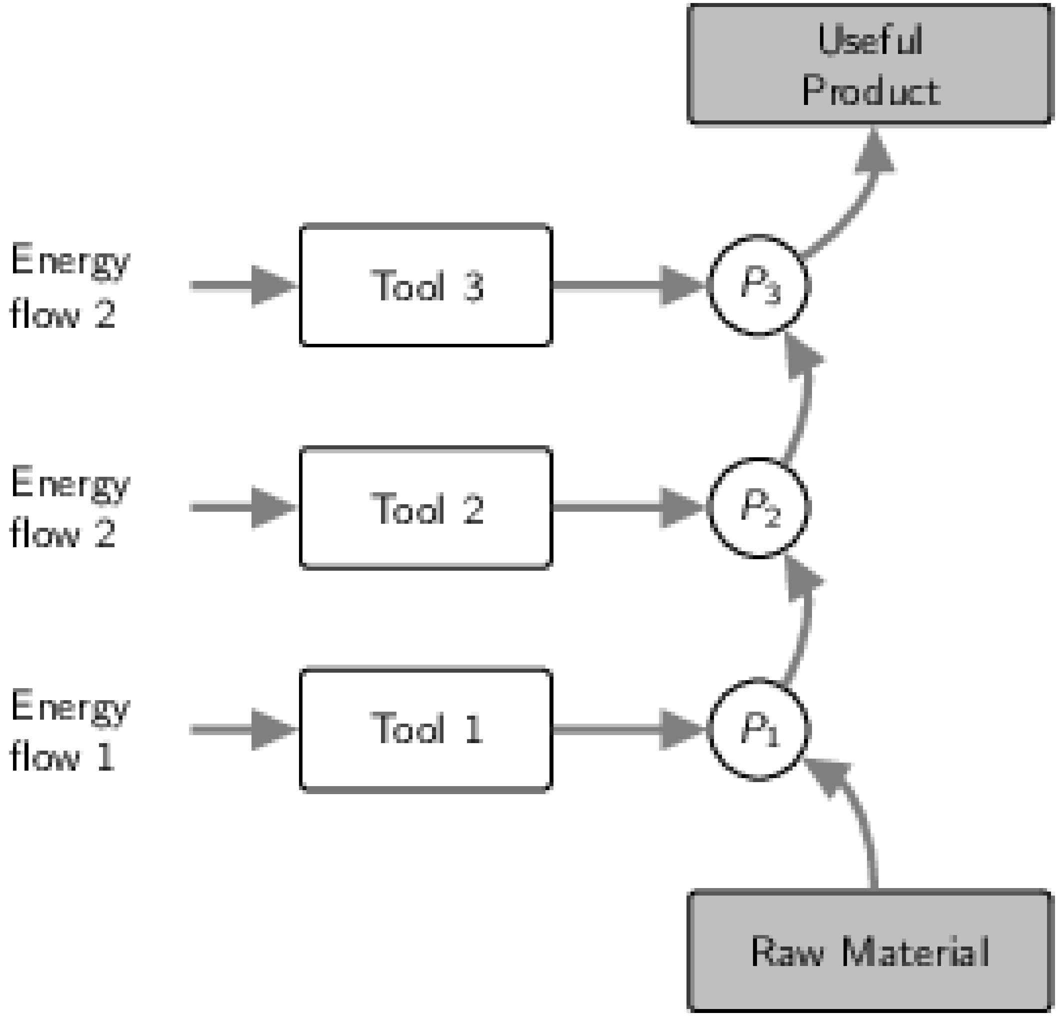
Another connection, which has not been considered much in the previous explanations, is the implicit appearance of flows in the (extended) TRIZ model of a technical system with the components energy source, propulsion, transmission, tool, processed object and control.

Indeed, it is about an energy flow with source, transformation into energy useful for the tool (the engine), flow of energy to this tool (the transmission) and transformation of the energy into a *state-changing effect* on the object (by the tool). The energy flow ends here at the tools and is orthogonal to the flow of workpieces.

Flows and Transmission

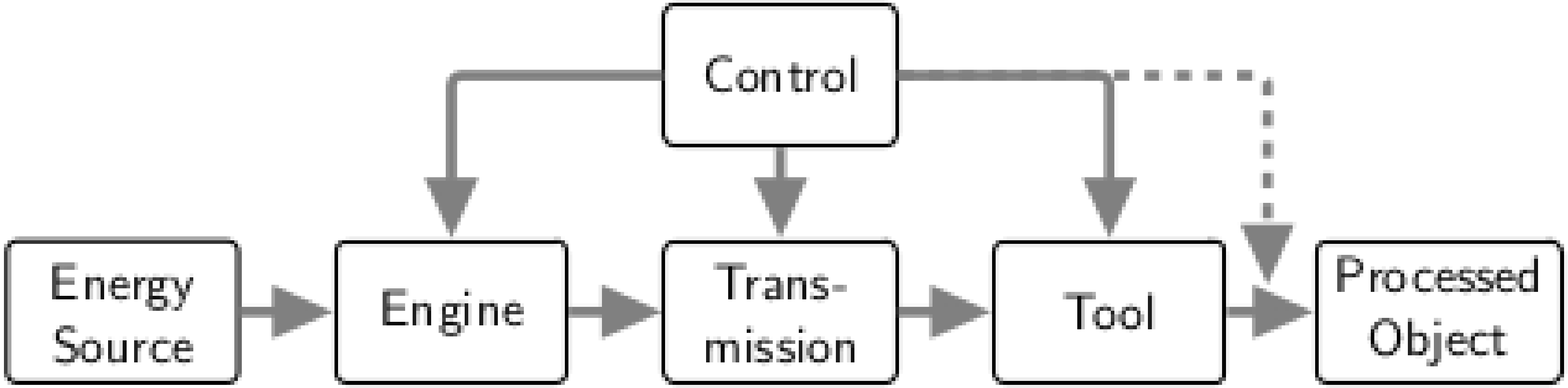
The same considerations about the interaction of quantitative and qualitative parameters as developed above for the energy flow also apply to the flow of substance. However, the target of this flow is not the tool, but the place (a central notion in Shchedrovitsky's system concept of first kind) that the workpiece occupies as object of transformation.

Flows and Transmission



Flows and Transmission

Adding the control to the technical system, the energy flow is joined with the flow and functional transformation of information. The close interlacing of both flows is expressed in the fact that in the abstract TRIZ model of a complete technical system the control not only affects the tool (and action), but also (potentially) the energy source, engine and transmission.



Conclusion

For many flows, it is difficult to identify concepts such as carrier, channel, source and sink. Flows with such additional structural properties are highly technically *enclosed flows* and more or less elaborated technical systems with very specific functional properties.

In the case of propagation of thermal or acoustic fields in a Substance-Field analysis, as well as in the case of the propagation of liquids and gases through diffusion or similar phenomena that are widespread in technical applications, a flow analysis can hardly be carried out in a targeted manner with the conceptual tools developed so far.

This does not devalue this work in any way, but raises the question how to frame the target of a flow analysis considered there in an appropriate way.

Conclusion

It is suggested to take more into account the distinction between system concepts of first and second kind in the sense of Shchedrovitsky and thus a distinction between structural and operational organisation.

In the transition to a system model of second kind, the functional properties of the components are only one of the ingredients which turn the relationship between tool and workpiece (object) into a *real-world state-changing action*. Additionally, their interaction with the flows of energy, substance and information is required.

Conclusion

The clear separation of the terms *component* as a stateless functional unit and the flow of *objects* as state-carrying units of instantiation as in Component Based Software Engineering is suitable for further terminological clarity here. This could not be explained due to time restrictions.

It is proposed to qualify the previous considerations on flow analysis as *Flow Functional Analysis* and to consider it as part of a more complex field of *Flow Analysis*, which in turn is a part of *Process Analysis* within a system model of second kind.

Thank you for your attention.

More on the WUMM Project at

http://wumm.uni-leipzig.de

https://wumm-project.github.io/

Flows in Computer Science

Due to time restrictions the part on flows in Computer Science and the relation of control flows to component composition and component models is skipped.

It discusses in particular the role of components, produced by independent third parties and being available as Commercial Off The Shelf (COTS).

This part is nevertheless quite important since the composition of TS from components is very common also in other engineering domains.