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Emerald Article: Making change happen: recollections of a systems professional

Markus Schwaninger

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SPECIAL FEATURE: ORGANISATIONAL CYBERNETICS

Making change happen: recollections of a systems professional

Markus Schwaninger
University of St Gallen, St Gallen, Switzerland

Abstract

Purpose – The purpose of this paper is to demonstrate the potential of making the systems approach fertile for the future of our world(s).

Design/methodology/approach – Underpinned by a significant case study, the idea of the paper is to show how a systems study changed the basis for deciding on an incisive interference planned for a lovely alpine valley. The study builds on a qualitative conceptual model and reverts to a quantitative, system-dynamics simulation model, as well as standard economic evaluation methods. The decision process is explained with its outcomes and implications.

Findings – The study found, among others, the following concrete result: The optimal variant (Case B) required an additional investment for its realization. According to the calculations that were carried out, the period needed for the amortization of the pertinent amount was found to be no more than 0.9 to 1.6 years. It became clear that the most expensive variant was indeed a very good business proposition for the Austrian Republic.

Practical implications – The results of the study were integrated into the General Traffic Plan of the Austrian Ministry of Transportation, Innovation and Technology, i.e. the study's conclusions obtained legal status. This meant a shift toward a long-term orientation. In addition, new insights for the realization of similar studies and interventions were gained.

Originality/value – The study described in the paper shows both rigor and relevance. It illuminates a methodology that combines the qualitative and the quantitative, as well as careful analysis and powerful synthesis. Beyond the methods and procedures used in the inquiry, its outcomes and impact on the concrete system under study are demonstrated.

Keywords Austria, Railways, Valleys, Sustainable development, Cybernetics, System dynamics, Modelling, Sustainability, System study, Multimethodology

Paper type Case study

1. Introduction

Our world is in crisis. This is a mammoth challenge for us system professionals. We can and must make change happen. Can we transform the earth? Not all at once, because our world is not a machine. However, we can move forward in our thinking, in our methodologies, and in our actions.

The purpose of this paper is to demonstrate the potential effectiveness of the systems approach to make change in management and organization beneficial.

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Complex problems and issues are ubiquitous, and so are the attempts to deal with them. Traditionally, the way to diagnose the situations, generate and evaluate potential solutions, and design strategies tend to be reductionist and mechanistic (Vester, 1997; Ackoff and Rovin, 2003). Analysis dominates at the cost of synthesis; in addition, the rationale is linear and does not consider feedback and delays. The multidimensional nature of the issues under study is not sufficiently taken into account. In other words, monodimensional approaches dominate: the observed system is considered as if it were nothing but an economic entity or nothing but a sociological entity, etc. Often the course of action is one of fragmentation. To take an example, in assessing the impact of a change on various environments, one tends to separate the economic dimension from the social dimension, and both from the ecological dimension, etc. One finds it difficult or downright impossible to combine these different aspects. The systems approach tries to avoid such fragmentation and reductionism, to achieve an integrative, holistic view of complex issues (Von Bertalanffy, 1968; Ulrich, 1985; Beer, 1988). Careful application and reflection of systemic interventions is necessary to demonstrate the fertility of the systems perspective in coping with complexity.

Other authors have presented works with similar intentions. A plethora of articles has been published about applied system studies, many of which abide by the principle of a holistic, multidimensional, and integrative description. A respectable number of these articles presents extensive, illuminating analyses of structures and change processes (Homer *et al.*, 2004; Sergeyev and Moscardini, 2006; Harwood, 2009; Bianchi *et al.*, 2010). Often, however, such works have paid relatively little attention to the results achieved, and they hardly reflect on their long-term implications, lessons learnt, unintended side-effects, alternative approaches, and the like (exceptions exist, e.g. Hall, 1973; Checkland and Scholes, 1991; Mumford, 2003). Usually these reports claim that the potential of the systems approach to bring about and sustain change in organizations or society is very high[1]. What is needed in addition are contributions that also show, by means of case exemplars, how this potential can be realized, what the outcomes of the respective projects in fact prove to be, and what they imply in the longer term. I am trying to make a contribution of this kind.

To this end, I have chosen to report on a pertinent case study. I am using a single case setting, namely, the proper research design for inquiries into unique and into revelatory instances (Yin, 2009). The study is about a weighty decision on an issue of exceedingly high complexity. To cope with that complexity, a multimethod approach was taken. The paper traces how different methods were combined within a systemic framework, to arrive at a decision whose superior quality could not have been attained if a non-systemic approach had been used. Qualitative and quantitative system dynamics, as well as standard analytical tools from economics (e.g. hedonic function, value analysis, income multiplyer) were used in a combined fashion to carry out the investigation.

According to scientific standards, decision-makers are supposed to assume a rational posture when confronted with complex, dynamic situations. They should test their assumptions and corroborate their resolutions with sound arguments, basing them, if possible, on quantitative reasoning (Black, 1999).

In practice, however, far-reaching decisions are often taken by relying on hunches. This approach is neglectful, however, of the nature of complex systems. These systems often exhibit behaviors which totally refute the presumption of the decision-makers. Particularly for those who rely merely on their own hunches, such results are

counterintuitive (Forrester, 1971). They are usually brought about by unknown couplings of critical variables or unintended side-effects, i.e. consequences that were not anticipated.

On the side of theory, however, management science provides devices for dealing with complex issues. It has not only developed algorithms for quantitatively orientated decision-making. It has also come up with many qualitative heuristics to cope with complex issues wherever quantification is impossible or contraindicated. Essentially, those who advocate either one of these approaches have by and large remained separate, bivouacked in two "camps". Consequently, there have not been many pleas for combining quantitative and qualitative methods or methodologies. However, the growing pressure for coping with complexity appears to be leading to a better understanding of the need for integrating the two domains, and of how to bring about such integration. But, dealing with high complexity needs something more than a combination of methods or methodologies. It requires a different conceptual framework. I am referring to a systemic approach, or more exactly to an underlying framework based on systemic thinking.

Systemic thinking deals with systems, i.e. organized wholes made up of elements and relationships. Complexity is a function of the uncertainty faced, the dynamics of the relationships, but also of the quantity and variety of the elements of the system-in-focus (Rescher, 1998). The dynamic complexity of a system may give rise to new properties of that system, a phenomenon called emergence. In a nutshell, systemic thinking is holistic-integrative and multidimensional, while also being dynamic, analytic and synthetic.

In the case under study it will be shown how a complex decision situation was supported by a system study which powerfully influenced the decision for the better in the social system affected. From a methodological point of view the study was remarkable in that a synthesis of qualitative and quantitative methods occurred, grounded in a systemic framework and customized to the issue at hand. It even occurred smoothly and to good effect. This was achieved on the basis of an innovative conceptual orientation, which provided to decision-makers a stronger lever than others for coping with the complexity faced when confronted with the difficult situation that will be described in the next section.

The case study will begin with a description of the context, i.e. the initial situation. Thereafter, the conceptual approach taken will be outlined. Then the steps of the decision process will follow, with decision analysis and synthesis. This will culminate in an account of the final decision. A reflective summary and outlook will conclude the paper.

2. Context

The Gastein Valley (Gasteinertal) in the county of Salzburg is a lovely spot, and one of the top tourist regions of Austria. Located at the rim of the alpine Tauern Mountains, it is connected to the north and the south via a railway coming from Salzburg in the north and continuing southward to Villach. The mountain is traversed by a tunnel leading from Bad Gastein to Mallnitz (Figure 1).

At the end of the millennium, the Austrian state decided to build a fast railway transversal across the Alps, leading through the Gastein Valley and opening a high-capacity connection along the north-south axis Salzburg – Villach, which would also open links towards Italy (Udine) and Slovenia (Ljubljana). This was a mandatory project, directly derived from the membership contracts of Austria with the European Union (European Union, Bundesministerium für Auswärtige Angelegenheiten, 1994).

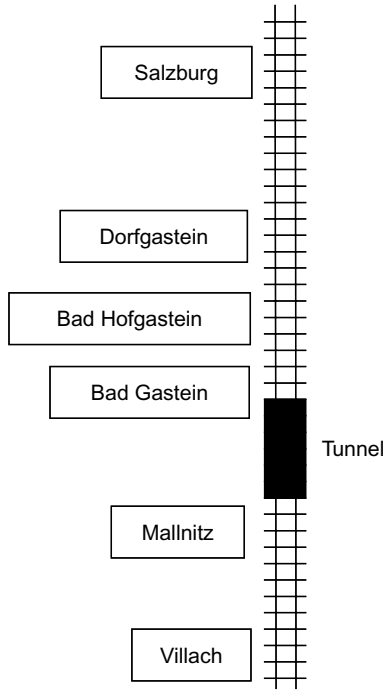


Figure 1.
Scheme of the train connections to and from the Gastein Valley

The project would include a new layout of the line as a heavy-duty track with two roadbeds, instead of one as in the past. It was foreseeable that such a project would have incisive consequences for the Gastein Valley. The new infrastructure would create large additional capacity which would imply the potential for a huge growth of traffic on that route. In relation to current transit frequencies, the new capacity would amount to a foreseeable growth of 662 percent (Schwanhäusser, 2000).

In the whole county of Salzburg and especially in the Gastein Valley, tourism is a very important economic factor (Scherrer, 1998). More than 30 percent of the work force of the Valley were employed by the hospitality industry. About 60 percent of all jobs in the area depended directly or indirectly on tourism. This comes close to constituting an economic mono-culture.

The tourism-related assets included:

- an outstanding ensemble of highly attractive natural factors (alpine landscape, flora, fauna, etc.);
- beautiful, originally preserved villages enriched by natural and cultural monuments;
- health resorts based on a famous and powerful curative resource (thermal springs containing Radon and a healing gallery with the largest natural inhalatorium in the world);
- an advanced tourist superstructure in both qualitative and quantitative terms (9,100 – mostly premium – beds in hotels and 7,700 beds in other facilities);

- a comprehensive tourist infrastructure (healing gallery, thermal spa, cure and rehabilitation centre, sport medical centre, thermal mineral springs, convention centre);
- an exceptionally spacious network of promenades and hiking trails;
- 200 kilometres of ski-runs rated at all degrees of difficulty, about 60 kilometres of cross-country skiing tracks, ten funiculars and 36 lifts; and
- a set of marked socio-cultural characteristics, including a strong tradition of hospitality and ethnic customs.

Based on this combination of attributes and assets, the Gastein Valley is highly attractive, in particular for health-oriented types of tourism. Many of these market segments, such as health vacation, fitness vacation, rehabilitation and cures, were growing in the target markets, particularly in Germany.

In sum, the following critical success factors for the Gastein Valley destination were identified (Schwaninger and Lässer, 2000):

- nature;
- health resorts (thermal springs);
- quietness/absence of noise;
- beauty of landscape and settlements;
- tourist infra- and superstructure; and
- socio-cultural factors, hospitality in particular.

It is chiefly the features of peaceful quiet and health resorts which establish the basis for awarding official health-spa status to both communities, Bad Gastein and Bad Hofgastein.

3. The need for a solution

At the outset, the Gastein Valley was located in a virtually transit-free zone. The high volumes of transit were absorbed by the Felbertauern tunnel to the west and the Tauern highway to the east. This balance would completely change with the construction of the high capacity rail route. The levels of increase in both emissions and immissions would depend on the technical solution, i.e. the chosen construction variant.

It was clearly discernable that major changes in two dimensions would occur:

(1) infrastructure (separation effects stemming from the new track, as well as the optical and therewith esthetical changes in the landscape); and

(2) immissions, namely noise and – to a limited extent – vibrations.

Since the beginning of the planning phase in 1989 until the opening of a mediation process in 1998, two camps confronted each other implacably. On the one hand, a group around the Austrian Railways (ÖBB) and the Ministry of Transport, Technology and Innovation favoured an open (uncovered) and thereby less expensive track layout arrangement. On the other hand, a group of citizens together with institutions related to the local tourism industry demanded a completely closed and therewith immission-minimal variant.

There was an urgent need to resolve this conflict and eventually to move toward a consensus in order to reach a sustainable solution. This led to the initiation of a mediation process.

The mediation forum was constituted by representatives of a number of organizations[2] or functions, namely:

- Austrian Railways (ÖBB).
- Ministry of Transportation, Innovation and Technology.
- County of Salzburg.
- Environmental attorneyship.
- Austrian Chamber of Commerce, tourism section.
- Municipality of Bad Gastein.
- Municipality of Bad Hofgastein.
- Municipality of Dorfgastein.
- Tourism Association Bad Gastein.
- Tourism Association Bad Hofgastein.
- Civil initiative "Lebenswertes Bad Gastein"[3].
- Civil initiative "Lebenswertes Gasteinertal – Bad Hofgastein".
- Austrian Alpine Association (ÖAV) – Section Bad Gastein.
- Civil Engineers Spirk & Partner.
- Attorney Dr H. Vana as representative of the municipalities and civil initiatives.

The forum decided to schedule regular sessions and to form task forces around core issues: Tracking variants for Bad Gastein, tracking variants for Bad Hofgastein, criteria for comparing the variants, noise, etc.

The leaders of the mediation forum asked me to develop a decision base which they called "economic assessment", to serve as a foundation for the decision process. I offered to work out a system study in cooperation with Dr Christian Laesser, the Deputy Director of the Institute for Public Services and Tourism, an expert on transportation and regional economics. We were put in charge and also offered all the resources available in the mediation forum. This included both the expertise of the citizens and specialists[4] involved in the project, and the many specialized studies and reports they had accumulated until then.

The decision that the construction of the high capacity railway (HCR) would be undertaken was definite and unquestionable, because it derived from a contractual agreement between the Republic of Austria and the EU (see above). The question, therefore, was not whether the intrusion should be carried out, but which one of the possible variants considered for that interference was to be realized. This study was meant to help the forum in taking its final decision.

4. The conceptual approach

The approach of the system study we envisaged had important implications:

- The study had to assess not only the economic effects of the planned intervention, but the social, technological and ecological aspects as well.
- It had to take into account the interrelationships between the variables of the multiple dimensions (economic, social, ecological) considered.

- It had to be dynamic, i.e. a static "photograph" of the situation after the interference, compared to the conditions at the outset, would not suffice.
- It should incorporate not only analysis but also synthesis in order to provide a comprehensive picture.

As a consequence, this would be a study of substantial complexity. The approach promised, however, to lead to a broader view and to deeper insights as a basis for decision-making.

We started with an investigation on the spot. This included visits of Bad Gastein, Bad Hofgastein, the main infrastructural components, hotels, restaurants, natural and cultural monuments, etc. We also had meetings and led interviews with exponents of the two constituencies. Finally, we gathered written documents and set-up information channels. Several local persons were designated to provide us with any further documents or data needed.

Back at our university, we conceptualized what we had learned. In the first place, we drew a conceptual and highly abstract map of the issue under study (Figure 2).

This was also the road map for our ensuing investigation.

The construction of the HCR was conceived as an initial "shock" which impinged on the core competencies and the critical success factors of the Gastein Valley. From there, two causal chains were identified which were rightly to become the object of detailed studies:

(1) Would the construction of the HCR have effects on the core competencies and critical success factors of the Gastein Valley destination (1a) and successively on the economic, socio-cultural and economic context (1b)? If yes, which would be the consequences and what would be their proportions? Ensuing feedbacks from core competencies and critical success factors (1c) were to be taken into account.

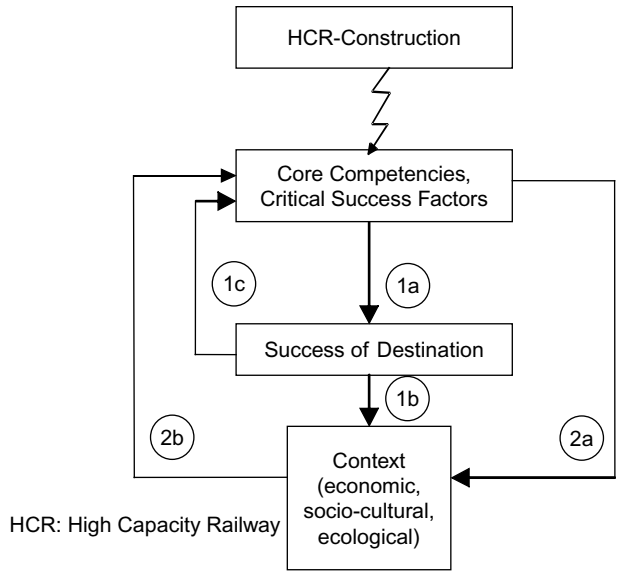


Figure 2.
Object of study – conceptual map

(2) Would the consequences of the HCR construction on core competencies and critical success factors entail implications for the context (2a), and if so which ones? Also here, eventual feedbacks from the context to core competencies and critical success factors (2b) were to be analyzed.

We then proceeded to a situation analysis. This included an examination of the contextual factors of transport policy, tourist trends, Gastein Valley as a destination, tourism assets, tourist demand, core competencies and critical success factors.

This analysis allowed us to operationalize and specify the programmatic scheme (Figure 2) with a view to framing the further steps of the study. Instead of the all-inclusive concepts of core competencies and critical success factors, we were now in a position to revert to more concrete terms related to the "original" assets (natural, socio-cultural) and "derived" assets (superstructure, e.g. hotels, spas, cable cars) (Figure 3).

The representation used in the diagram is a common feature of qualitative system dynamics. While issues of the type studied here are usually represented by means of open causal chains, we favor the approach that relies on closed loops. These capture a characteristic feature of complex systems: feedback loops, i.e. the causal connections leading from a variable back into itself. Also delays, another characteristic feature, can be depicted in this kind of diagram – here by the double orthogonal bars on some of the arrows.

In the present case, we can identify two main, self-reinforcing "attractiveness loops" (Vester and von Hesler, 1988) with further ramifications.

The inner, primary attractiveness loop shows the influence of key variables of the original environmental package or set-up, namely landscape, nature, quietude, beauty of

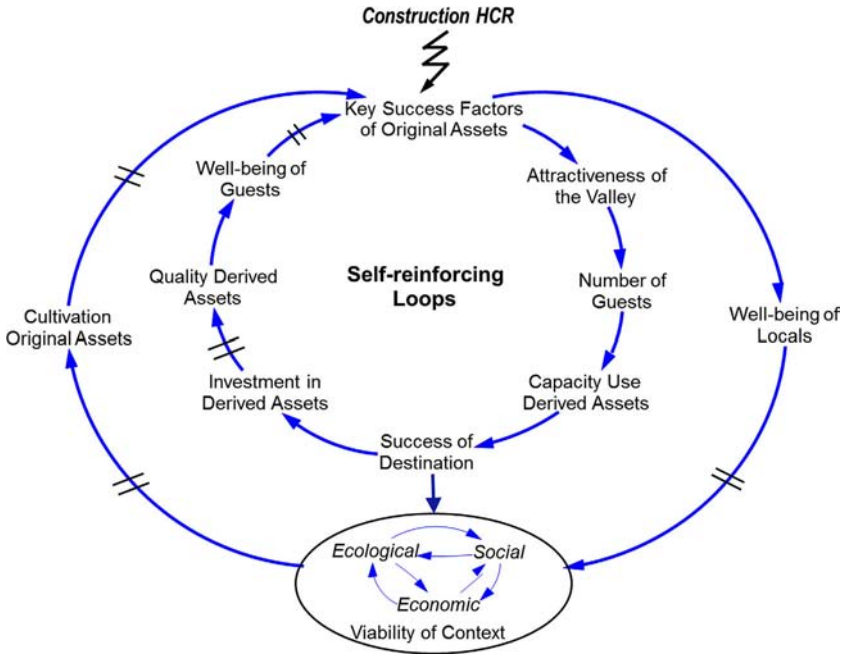


Figure 3.
Causal loop diagram

villages and cultural conditions. These variables, by and large, determine the well-being of guests and (in part directly, in part indirectly via the well-being of guests) the attractiveness of the valley, which is decisive for the number of changes in the number of guests. The capacity use and the economic success of the destination (both measurable in hard figures) would change as well. These changes would have consequences for the investment and thereby for the evolution of the quality of the derived set-up (infra- and superstructure). That very quality again impinges on the well-being of guests and the attractiveness of the valley.

The other, indirect and secondary loop on the outer side of Figure 3 centres on the internal context of the Gastein Valley, a context which is economic, socio-cultural and ecological. This context on the one hand is stamped by the well-being of local inhabitants. On the other hand it is influenced by the success of the destination. Via the two variables "cultivation of the original set-up" and "well-being of locals", the context is coupled with the key variables of the original set-up ("original assets").

Both loops are closed and self-reinforcing, but reciprocally connected. They are influenced by only one exogenous variable – the construction of the HCR.

The sequence ran by and large from synthesis to analysis to synthesis. First we looked at the larger system of which the HCR is part, i.e. the Gastein Valley as a whole and its properties. Then we went about accounting for the behavior of that larger system as a function of the impacts of the HCR in different dimensions. Finally, we put these partial aspects together to explain the role of the HCR within its containing whole (Ackoff, 1999).

5. Decision analysis

The study proceeded to an extensive analysis along the lines traced by the conceptual schemes (Figures 2 and 3). Accordingly, the analysis was made up of three blocks, namely:

(1) effects of the construction of the HCR on key variables of the original assets;

(2) the primary causal loop; and

(3) the secondary causal loop.

In each one of these blocks, the pertinent variables were examined one by one. This refers to all the variables as listed in the causal loop diagram. In some instances the analysis even went down to a more detailed level; for example, in the case of the key variables (block 1) certain theoretical foundations were given; then the analysis examined quietude/noise, nature, beauty of villages and landscape, health resources/recreation factors, socio-cultural factors and hospitality in particular.

In the case of the inner, primary loop (block 2) the objects of analysis were the number of guests and capacity utilization, success of destination, investment in infra- and superstructure, quality of infra- and superstructure and well-being of guests.

The variables analyzed in relation to the secondary loop (block 3) were the well-being of locals, the economic context, the social context and the ecological context. In the case of the economic dimension, a number of partial aspects were examined, i.e. income and purchasing power, evolution of value in the hospitality industry, evolution of value in the other components of the derived tourist offer and intangible effects.

As far as these variants of the layout of the HCR are concerned, the picture was complex. For the Bad Gastein area alone, five variants of the track layout were established, and for Bad Hofgastein there were five additional ones. As the former ones could theoretically be combined with the latter ones in any way, the theoretical number of possible variants amounted to 25. Of these, the eight most plausible ones were examined in detail.

In the first place, the analysis referred to two ideal-types, namely:

(1) Case A: by and large open-track, via a short tunnel in the region of Bad Hofgastein (Variant 1) and incomplete coverage in Bad Gastein (Variant 8). This was the track as established, at the time, by the Austrian Railway Law.

(2) Case B: by and large closed-track, via a long tunnel in Bad Hofgastein (Variant 3), a complete tunnel in the area of Bad Gastein and a cavern station (Variant 2).

These were the reference variants for the analysis.

For each one of the variables or partial aspects thereof, the analysis detailed first the basis for the assessment, and then proceeded to an evaluation of the consequences. In each case that evaluation was specified for the two reference variants of the HCR construction.

In the case of the variable "health resources/recreation factors" – for example, the indications treated in Bad Gastein[3] – the weight of the natural factors and the impact of noise (permanent and peak noise levels) were ascertained in the section "basis for the assessment". In the section "evaluation of the consequences", disturbances and effects on health and rehabilitation processes, as well as detriments to aesthetic qualities, were identified. For Case A the transgression of noise standards as prescribed for the official health-spa status would happen; this would lead to attrition of that status. For Case B a slight improvement of the basis for recreation and rehabilitation was foreseeable (except for the period in which the construction would be carried out).

The analysis was orientated by the conceptual schemes drafted at the outset (Figures 2 and 3). The logic of the analysis was essentially that of the sensitivity-analysis type. The pertinent question was: "How will the dependent variables react to different changes of the independent variables?" Much of this had to be answered in qualitative terms. These results were made comprehensible due to the highly structured nature of the report.

On the other hand, much of the analysis was conducted along quantitative lines. The yearly costs and benefits for the reference variants were calculated in a detailed mode. The value of the investment in the railway had to be considered. Changes in tourist-generated income, regional income, tax yield, etc. were calculated, changes in wages, jobs, investments and value of the tourist infra- and superstructure had to be determined as well. This made extensive data collections and also a detailed modeling necessary.

It lies beyond the scope of this paper to reproduce all the functions of that model here. However, three examples should give an idea of how qualitative constructs were translated into meaningful quantitative indices:

(1) In the section about noise and its consequences, we referred to a hedonic pricing model by Pommerehne (1988), which allows one to deduce changes in the value of properties (via changes in rents) as a function of noise levels. The formula is:

$$\mathrm{Ln\ M} = -0.002943 * \mathrm{dB1.3},$$

where M is the level of rents in Swiss Francs and dB the noise level in decibels.

(2) The construct "success of the destination" (primary loop) was operationalized by means of two indicators, the change in income from tourism and the value-added generated by the hospitality industry. The formulas were:

$$\Delta TGE = \Delta L*1000, \tag{2.1}$$

where *TGE* is the total income of the valley from tourism, *L* the number of over-night stays of tourists and 1,000 an empirical value of the daily expenses of tourists (in Austrian Schillings):

$$\Delta WS = \Delta TGE*0.62*(BE - WA - ABS), \tag{2.2}$$

where *WS* stands for value-added, *BE* for the income of the local hospitality industry as 100 percent. *WA* and *ABS* are the respective percentages to be deduced for the cost of merchandise and depreciation. 0.62 is the hospitality industry's fraction of the income from tourism.

(3) Under economic context (secondary loop), the macroeconomic income generated was calculated as follows:

$$\Delta Y = \Delta TGE*\mu,$$

where Y is the macroeconomic income generated by tourism and μ the macroeconomic multiplier (calculated with 1.37, a value ascertained empirically: Häusel (1985).

In a final section the results of the analysis were broken down to the level of the further variants, by means of a rough quantification. The comparison of the qualities of the different options came down to a set of scores on a scale between 0 (for Variant 8, i.e. Case A) and 1 (for Variant 2, i.e. Case B).

6. Synthesis and decision

The synthesis was carried out at two levels, the level of the three blocks of the analysis and the level of the total of analyses. The synthetic judgments were again underpinned by both qualitative and quantitative methods.

First, at the end of each block of analysis a synthesis was undertaken which showed the larger picture, for example in case of the first block the overall change in attractiveness of the valley. Case A would have disastrous consequences for each one of the components of the original offer as it also would for their totality. It would be a "devastating plan, ruinous for the whole valley" (König, 2000), where the loss of the status as a health spa would only be one partial effect. The fateful process would start with an almost immediate loss of – modestly calculated – at least 15 percent (i.e. 300,000) of the guest nights, essentially due to the additional noise. And it would have strong and undesirable side-effects.

Case B was in sum the one with the relatively least negative consequences. Some advantages, compared with the status quo, concerning noise and landscape in the area of Bad Gastein and Bad Hofgastein would still be compensated by two disadvantages: the increased traffic volume would affect Dorfgastein where no tunnel would be provided. Furthermore, during the period of construction, unrest, noise and complications were anticipated.

Similar syntheses were carried out concerning the primary and the secondary loops. Both were identified as vicious loops, and in the case of Variant B the "vice" was even found to be disastrous.

The synthesis at the level of the whole had to bring the partial aspects together in clear-cut and easily comprehensible categories. The qualitative approach consisted in putting together all the partial, descriptive results of the analysis in a synoptic manner and lodging them in a special chapter. The quantitative approach resulted in a synthesis of economic results in another special chapter as well.

In addition, a small, highly aggregated, quantitative system-dynamics[5] model was built on the basis of the conceptual scheme in Figure 3. The Stock-and-Flow difagram is shown in Figure 4. It represents the structure of the system-dynamics model. Stocks are represented by boxes, flows by valves, with the other variables being auxiliary. Underlying this structure is a set of differential equations which trigger the simulations.

This model generated a result which the economic analysis had not been able to deliver, namely an overall account of the dynamic evolution of the valley's economy in the years to come. The most expressive result of the respective simulations is shown in Figure 5.

The main lesson delivered by this curve is that the results would be significantly worse than the ones calculated by the economic analysis: that scenario was calculated on the basis of a 15 percent reduction in guest nights (from 2 million to 1.7 million) within the first three years, at the outset for Case A. This was still in accord with the results of the economic calculus. The SD model, however, showed a decline of guest nights,

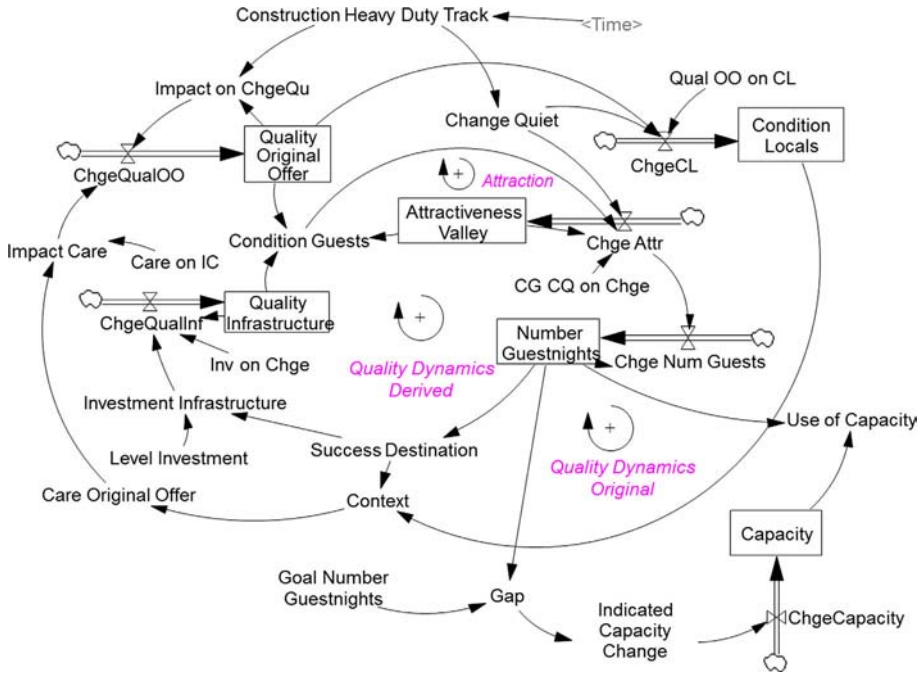
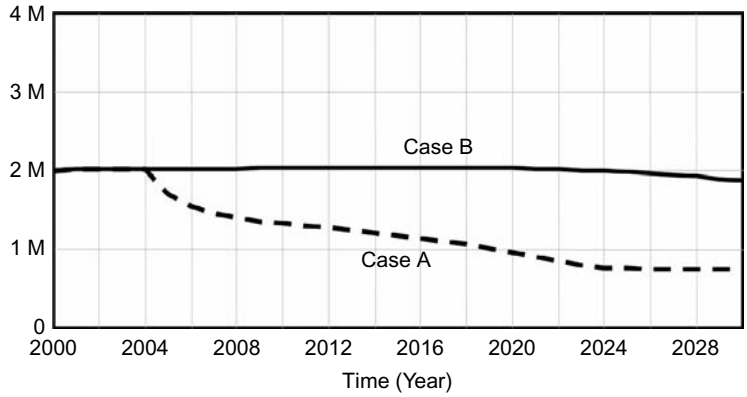


Figure 4.
Stock-and flow diagram of the system-dynamics model



Note: Scenario for Cases A and B

Figure 5.
Evolution of the number of guest nights over 30 years

from the initial value of 2 million, by 34 percent within the first decade and a further reduction up to 52 percent by the end of the second decade (Figure 4).

Finally, here are the results of our investigations, which were presented as a basis for the pending decision.

First and foremost, our study showed that the planned intervention was a counter-systemic interference, whichever variant would be chosen.

Second, our report culminated in the following recommendation:

> The minimum of immissions achievable with the most gentle variant is equal to the maximum of what is still tolerable.

In other words, the study had led to the conclusion that out of the many options for the HCR layout studied the most environment-friendly variant (Case B) was superior to all the others not only in ecological terms but also, and to a comparable degree, in macroeconomic and social terms.

The study had found, among others, the following concrete result: the optimal variant (Case B) required an additional investment for its realization. According to the calculations that were carried out, the period needed for the amortization of the pertinent amount was found to be no more than 0.9-1.6 years. It became clear that the most expensive variant was indeed a very good business proposition for the Austrian Republic.

The most intriguing observation that we made during the entire process concerns the fact that our report had an integrative impact on the mediation forum. We presented our results to the forum's plenary sessions twice. The first instance was in the middle of the study period, when the overall direction was clear but only a few of the details were apparent, and the second one, when the report had been finished. During the time we worked for the forum, we observed a successive convergence of views among the participants. At the end of the process there was a strong consensus, with no significant opposition.

In 2001 the definite decision to adopt Variant B was taken by the forum, on the basis of our study. This decision was formalized in a mediation contract which was signed by the representatives of the Austrian Railways (ÖBB) as well as the mayors of the most concerned villages. Thereupon the contract was submitted to the federal authority – the

Austrian Ministry of Transportation, Innovation and Technology. That Ministry integrated the decision into the General Traffic Plan ("Generalverkehrsplan") of the Republic of Austria. In other words, our recommendation obtained legal status. The plan was to be implemented by the Austrian Railways, while the Austrian State would provide the necessary financial resources. A transition towards a long-term orientation had occurred.

7. A meta-systemic reflection of the project

Once a project has been described as this one has, one should ask why it succeeded or failed, and gauge the generative "mechanisms" which produce these outcomes. In the present case, it is imperative to examine the structures that underlie the intervention and make it effective.

For this purpose, I will revert to a classical cybernetic tool of organizational diagnosis and design, the viable system model (VSM) (Beer, 1981, 1985). The question I will address is: "Why did this intervention work?" I am referring to the intervention of the mediation forum, supported by our study.

The VSM is a theory that specifies the preconditions for the viability of an organization. "Viability" is not a dichotomous variable, but is ordinal-scaled, following a rationale of assessing higher or lower degrees of viability. To date, the VSM is the only proven model for this kind of assessment.

As this model has been laid out extensively elsewhere (Beer, passim; Pérez Ríos, 2008; Espejo and Reyes, 2011), I will limit myself to briefly introducing the main principles relevant for this diagnosis. According to the VSM, an organization is viable if and only if it exhibits the following six organizational functions:

- *System 1*. Basic operational units with their regulatory capacity ("management"), striving for their local optimum – "Implementation".
- *System 2*. Coordination and attenuation of variety between the Systems 1, through information and communication – "Coordination".
- *System 3*. Vertical regulation, optimization of the interplay of Systems 1 – "Control".
- *System 3**. Validation of information flowing over the System 2 channels – "Auditing", "Monitoring".

The coaction of Systems 1, 2, 3, and 3* enhances the cohesion of the organization:

- *System 4*. Intelligence, dealing with the overall environment and the long term – "Intelligence".
- *System 5*. The ethos of the system – values and norms – which moderate the interaction of Systems 3 and 4 – "Ethos", "Policy".

The better these six functions are fully operating and interacting as specified in the theory, the stronger the viability of the organization. Insufficient capacities or interactions of the functions result in an impairment of the viability[6].

The project – let us call it the "Gastein project" – is a citizen's initiative to ensure the sustainability of the Gastein Valley in social, economic and ecological terms. Different stakeholders are involved in the project. The object of the following diagnosis is broader than the project as such, because it is about three communities joining forces to confront a challenge collectively. The system-in-focus, then, is the Gastein Valley

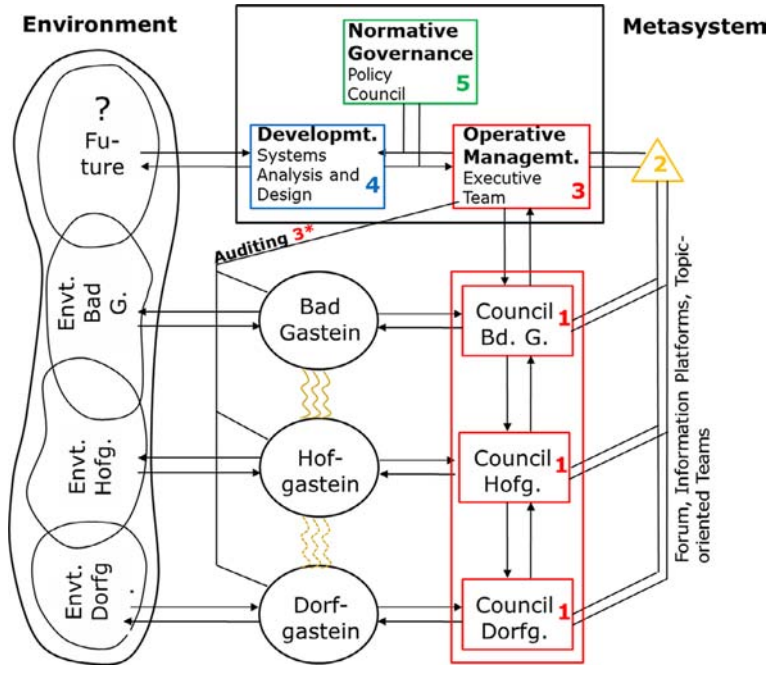
as a whole, confronting the issue of an imminent interference with strong economic, social and ecological implications. An analysis of the regulatory structure inherent in that system-in-focus leads to a synthetic picture as shown in Figure 6.

This view of the organization of the Gastein Valley relevant for the project under study identifies the following.

Environment. On the left of the diagram, the specific environments of the three settlements in the valley are distinguished. In addition, the future environment, which is largely unknown (field with question mark), and the overall environment pertaining to the valley as a whole (envelope) are shown.

System 1. The three communes as basic units are governed by their local authorities, essentially the municipal councils presided over by the mayors.

System 3. Initially, there was no formal institution in charge of global vertical regulation in the sense of a management of the Gastein Valley. It turned out, however, that in the process there soon emerged a joining of forces among key agents, namely the three mayors, three NGOs (non-governmental organizations) – Civil Initiatives Bad Gastein and Bad Hofgastein and the local chapter of Austrian Alpine Association (ÖAV) – as well as a representative of the Austrian Railways. These agents rendered different contributions, but all of them, and the assignments given to the organization were perfectly coordinated among them: all their decisions were based on consensus[7]. Organizational topics were decided in this group: timeline of the project, expenses, provision of manpower. Concretely, common goals (short to medium term), e.g. concerning the next phases of the project, were negotiated and pursued, always



Source: After Beer's (1981, 1985) VSM

Figure 6.
Structural view of the Gastein Valley

being linked to their long-term concern: the insistence on a minimally invasive intervention in the valley. System 2: the mediation forum was constituted by the crucial carriers of relevant information. They met regularly, approximately every two weeks. This way a platform was provided in which participants exchanged information regularly. In these meetings, the newest results of assessments, and the current state of ongoing discussion in the stakeholder institutions (municipality, county administration, ministry, Austrian Railways, etc.), were presented and discussed. Thus, all constituencies were continually updated, and a shared "mental model" gradually formed. No doubt, too, casual encounters between members of the forum outside the official sessions also contributed to this emergence of a common view.

*System 3 **. Such informal encounters had a validation function, whenever the mayors interacted with citizens: they learnt about non-official positions or concerns, and could ascertain if these either corroborated the perspective of the forum or added something new to it.

The mayors were not the only ones who communicated with citizens. In this vein, one must also consider different kinds of public or semi-public events, which were connected with the Gastein project in some way, therewith fostering cohesion of the population[8].

System 4. The opinion leaders who had initiated the mediation forum were primarily concerned with the destiny of the valley as a whole and in the long run. They were backed by other members of the forum in their endeavor for a sustainable strategy, and they triggered the hiring of external consultants who would assess, rationally and professionally, the state of the valley before and after the planned intervention, in the long term. Scenarios would be elaborated and "What-If" questions raised. Some of these consultants looked into partial aspects such as noise, ecology and economy. Our role was to bring these partial aspects together in the system study.

System 5. The ethos of the whole system was essentially marked by a core team of people from the mediation council. They shaped the values governing the project, and these values were not detached from the ethos of the valley as a whole. In the end those values were the embodiments of an essentially timeless identity that marked the Gastein Valley: a community with a sustained commitment to the quality of life, the unity of man and nature, and a healthy, prosperous society.

To summarize, virtually all of the VSM functions were in place, and at a strong level. It turned out that the mediation forum was crucial, in that its several constituencies nourished different functions (1-5). Bringing the pieces together, one may conclude that this project showed an exceptionally (and surprisingly) complete set of powerful structural entities making up a viable system. The cogent implication of this structural diagnosis is that the project was bound to be a success.

8. Conclusions

The case study reported on here brings several features to the fore, features which characterize a systemic approach to studying complex and dynamic issues.

The system under study exhibited exceptionally high complexity. The whole valley's socio-economic existence was challenged by the planned construction of an HCR.

That intrusion and the ramifications of its effects as studied in this project made up a multidimensional web of relationships susceptible to analysis. That web produced a dynamic pattern which only a synthetic approach could fully elicit.

This study was a systemic one, which is expressed in several features: first of all, it was multidimensional, holistic and integrative. This is remarkable insofar as studies of this kind tend to be limited to one dimension, whether economic, psychological or social and so forth; and they are also often static. This study was multidimensional in that several dimensions – in particular the economic, social and ecological dimensions – were examined. It pursued a holistic approach as it focused on the larger whole and integrated the partial aspects of the different dimensions into a larger picture.

Furthermore, the study was based on a dynamic view. The dynamic patterns elicited, e.g. the long-term evolution as drawn by the system-dynamics model, were not only a useful but also a necessary ingredient for an understanding of the situation.

Finally, this study coupled analysis and synthesis. This combination stands in contrast to the monochromatic dominance of analysis and the lack of synthesis widely observable in studies of a comparable kind. However, this combination of analytic and synthetic reasoning is a basic feature of systemic thinking, a feature which is vital to a deeper understanding of a complex issue (Ackoff and Rovin, 2003).

It is cogent to argue that the results of a less systemic study, i.e. one not showing such multidimensionality, dynamics, and synthesis, etc. could not reach the depth and richness achieved in this case for both the investigation and its conclusions. Besides the richness of the conclusions presented in the final report, one must, e.g. take into account the valuable insights conveyed by the systems diagrams, the closed loop diagram (Figure 3) in particular. This richness offers a better basis for decision-making in a complex, dynamic environment than the one-dimensionality of more reductionist studies.

Both the analytical and the synthetic components of the study made use of qualitative as well as quantitative approaches. Neither one nor the other was sufficient in itself. The combination of both proved to be necessary. The qualitative analysis was extensive, yet the partial conclusions drawn on the basis of that analysis were highly differentiated and not easy to integrate into a conclusive picture. Contrary to many other cases, however, all of them pointed in the same direction. This fact by and large facilitated their integration. In addition, the qualitative investigation widened our horizon in that it brought detailed and sometimes hidden structures to the fore, which otherwise would not have been taken into consideration.

At any rate, the quantitative methods were an essential complement of the qualitative ones. They were not conceived as a mysterious calculus, leading to an end-stage figure about costs and benefits. On the contrary, the result was a clear quantitative account which translated qualitative deliberations into economic figures, as far as it made sense to do so. Assumptions were specified throughout; the whole calculus was transparent and capable of being duplicated. Intangible aspects such as the beauty of nature or the perils of ecological degradation were not quantified, but verbalized in the report.

In addition to the relatively static calculus, a dynamic model was constructed which showed the long-term dynamics of the socio-economic evolution of the valley. That model showed that the results of conventional calculations underestimated the fatal consequences of the planned intervention. The insights triggered by the simulation results raised collective awareness within the forum.

As is usually the case with this kind of study, not all aspects can or should be quantified (Vennix, 1999). Therefore, the calculations were complemented by the additional qualitative arguments (see above). If we had worked only qualitatively,

it would have been much more difficult to take a decision, which is generally the problem with "thick descriptions" (Geertz, 1973). Had we worked only quantitatively, however, the basis for the decision would have been narrower and incomplete.

Altogether, this was a case of applying systemic thinking to a complex situation and thereby generating superior results in comparison to what might have been achieved with traditional approaches.

Most important, though, is what remains once the method has been accounted for. The study triggered a more careful and sustainable intervention: it was a vital ingredient in the decision-making process, and ultimately proved to supply a crucial argument for choosing the most beneficial, although most demanding, of the variants. The implementation of any other variant would have had a negative impact on the valley in social, economic and ecological terms. Depending on the variant, that impact would have ranged from dangerous to disastrous.

The study was crucial for overcoming the profound conflict between the stakeholders. Finally, it enabled the decision in favor of the sustainability and viability of the Gastein Valley. The long-term view had won. In this sense it is no exaggeration to claim – *cum grano salis* – for the case in point, that a valley was saved by means of a study based on system theory and cybernetics. The question at the outset of this paper was: "can we change the world?". The world is not a machine; therefore we can [. . .] provided we change our thinking.

Aftermath: in 2010, i.e. ten years after the realization of the study, I visited the Gastein Valley for an on-site inspection. I discovered that construction had not yet begun. If and when something will be built, it will proceed according to the recommendations produced by the inquiry.

Notes

1. However, these reports often remain in the theoretical-conceptual mode or they do not rigorously document any change brought about in the "real world".
2. The elaboration of a written mediation contract ("Mediationsvertrag"), as defined by Austrian law, was the goal of the forum. Such a contract would condense the final outcome of the project, i.e. the decision taken by the forum, and be binding for the governmental and the civil parties. The document would be presented to the federal authorities.
3. "Lebenswert" stands for "liveable."
4. This included many experts who were not members of the mediation forum, but were contracted for specific assessments of, e.g. technical, ecological and legal aspects.
5. System dynamics is a methodology for the modeling and simulation of complex systems. It was created by Prof. Jay Forrester at MIT. The simulation models rest on differential equations. Characteristic of these models is an endogenous view, i.e. the use of exogenous parameters is minimized, feedback is embodied in causal loops, and the inclusion of delays enters into the calculations (Forrester, 1961; Sterman, 2000).
6. To complete the picture, the structure outlined here is recursive, according to the recursive system theorem: "In a recursive organizational structure, any viable system contains, and is contained in, a viable system" (Beer, 1979). In other words, one and the same structure is applicable to organizations of different levels, e.g. to a company (in this case the system-in-focus), and equally to its constituent divisions (the subsystems), as well as the corporate group (the encompassing suprasystem). Equally, this logic can be applied to our case: a valley and its component villages,

as well as the region of which it is part. The VSM can be used as a diagnostic and design "tool" at any one of these levels.

7. The motives furthering cooperation had different origins: the mayors were continually confronted with complaints about growing noise levels, which had already materialized since, in the wake of the EU contract, rail traffic was already on the rise (+35 percent of train movements in 1998, as compared to 1994; trains getting heavier and faster, with normal noise levels of 90 decibels). In addition the elections were approaching, which was an additional incentive for the mayors to act on that problem. The NGO representatives were highly complementary: two of them (Civil Initiatives Gastein and Hofgastein) represented the economic and social perspectives, while the Alpine Association (ÖAV) stood for the ecological point of view. This complementarity induced a climate of mutual support and favoured cooperation.
8. One example is the general assembly of the ÖAV Gastein, where a committee decision was taken to support the project, in coordination with the ÖAV Innsbruck. The assemblies of the Civil Initiatives are, a second example, where additional members were required to sign motions that served as a prerequisite for their representatives to become part of the leading team in the mediation forum (see System 3); 200-300 signatures were necessary.

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Corresponding author
Markus Schwaninger can be contacted at: Markus.Schwaninger@unisg.ch