Report on mechanism of social engineering
Realising hydro projects by involving stakeholders

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1. Introductory remarks

1.1 The global need

The development of the society has been an extremely quick one within the past few decades. Rapidly increased knowledge on interactions between all different kind of human activities combined with high speed and world wide information raised a general awareness of the population related to any kind of alteration. Human development is necessarily causing alteration in terms of economy and environment. The urgent need for a better social embedding of all kind of alteration is a logical result of this development.

The traditional meaning of the word “engineering” includes the entire sector of technical efforts in developing projects and technical solutions. For a very long period the technical feasibility has been the crucial criteria for realisation. Due to the continuously advancing technical excellence increasing the costs the economical feasibility of a project superposed any decision process, serving as a second, significant criterion.

Both the awareness of people towards any alteration of their individual environment but also the dimension of projects has been increasing rapidly. A completely new aspect of “engineering” in a wider sense of its meaning has to be developed – the so-called “social engineering”, focussing exclusively on non-technical aspects within the project implementation.

Obviously aspects and activities in terms of social engineering will be of high importance whenever technical or economic arguments are not sufficient to persuade people involved. Apart from the individual need, social engineering should become an obligatory part of any engineering process in a wider scope.

There are a few classical fields of application where technical engineering accompanied by economical aspects is the basis but there is additional need for “social work” making the project a successful one: waste disposal sites, airports, freeways, high voltage lines, nuclear power plants but also hydropower plants. This selection of well known focus points shows, that social engineering is a general task and there is global need for it.

This report is focussed on different aspects of social engineering in the context of hydropower plants. Despite this specialisation some of the criteria and mechanism are still general, but some others are very specific meeting the peculiar features and demands of hydropower.

The field of applying strategies and methods described by the term “social engineering” is a very large one and range from large projects as mentioned above to individual private houses or from the first project idea to the final implementation.
1.2 Social engineering – a key element of sustainable engineering

Looking at the traditional definition of sustainability it becomes clear that social engineering is an essential and unavoidable part of it. Everybody dealing with sustainability knows best the problems of criteria and indicators. It is ambitious in terms of economy, it is difficult in terms of environment and it is a challenge in terms of society.

Sustainability is not a static condition but a process, reacting on variables. Social engineering has to react on human variability which is the most unpredictable task.

1.3 Concern as the driving force

Social engineering can be seen as methodical approach to overcome opposition against a project. To find solutions it may be helpful to find out the reason of opposition which may be manifold. Still remaining on general level any opposition is based on concerns which are based either on facts or on emotion. Of course in many cases we are facing a mixture of both. Nevertheless the reason for the concern makes the big difference. Factual concerns can be met by rational arguments – emotional concerns have to be dealt with on emotional level.

What kind of concerns do people have?

- Concern of losing money
- Concern of personal safety and health
- Concern of having any kind of disadvantage
- Concern of decrease of living condition
- Concern of any unexpected alteration in their life
- Concerned to be tricked

The intensity of the concern is usually but not always direct proportional to the size or intensity of the alteration itself.

In simplification it can be said that “total concern” is combined of both types of concern which can be exchanged up to a certain degree.
Anyway – to deal with all the aspects mentioned needs communication and consequently the willingness to communicate of all parties involved. Without this precondition the majority of “social engineering tools” cannot be applied.

1.4 The target of social engineering

Social engineering means accompanying technical and economic aspects with the great variety of social aspects. Social engineering will never stand alone. Necessarily it needs a project to deal with. The final target is the factual implementation of an idea.

1.5 Applying the general idea on hydropower exploitation

Electricity production from hydropower is undoubtedly a task of public interest. Nevertheless a certain part of the population will not recognise the close relation between individual electricity consumption and electricity production although electricity has become an unavoidable part of our life.

Hydropower exploitation is a very special task concerning public interest because there is a conflict with the environment being also a matter of public interest. In both cases there are different emotions involved. In the early years of European hydropower exploitation the engineers involved became almost heroes because the result of their activities was electricity and electricity was the driving force for economical prosperity. In the previous twenty years electricity has become a matter of course and the very positive attitude disappeared. Nowadays the lack of knowledge but also the lack of information seems to be the main barrier against public acceptance.

There are many approaches to achieve the target of public awareness and acceptance of small hydro and according to the individual options as many of them as possible should be applied together. The following aspects to be discussed should not be seen as an obligation but an offer to be taken in case of real need. It will not be possible to apply all strategies to every project. The idea behind the examples discussed may encourage open-minded engineers to implement hydropower projects even under conditions which may seem to be hopeless.
2. The tools

The great variety of approaches recommends at least a simple structure. The application of the tools may happen at different stages of the project development. The order taken below follows roughly the process of project development. Of course a conceptual strategy has to be applied at the very beginning of a project and the question of ownership can be solved even in a very final stage. Anyway there are four large groups of tools to be discussed in detail:

- Conceptual strategies
- Operational approaches
- Involvement
- Ownership and identity

2.1 Conceptual strategies

Usually, at the very beginning of a project, the engineer faces a complete one-dimensional job, defined by the principle: design and implementation of a small hydro plant. It remains for the competence, the experience and the art of the design engineer to embed the one-dimensional idea into a wider, comprehensive concept, receiving positive public interest. Conceptual approaches belong to engineering, but need also to be multidisciplinary and it is necessary to recognize sometimes complex links between them. These are the means of transporting the core-idea.

2.1.1 Changing priorities: environmental concepts and additional small hydro development

Many of the rivers which are attractive for small hydro development have had hydraulic works installed in the past, aimed at lowering the risk of flood or increasing the river stability. The ecological quality is sometimes quite poor but little happens because of a lack of funds.

The implementation of a small hydro plant may in fact be able to increase some ecological parameters, provided the design becomes environmentally sound. Nevertheless, if the official target of the engineering project is the construction of a small hydro plant, people will tend to interpret some environmental measures as an ineffectual attempt to compensate for severe ecological destruction. The better way is to change the priorities. The main target of the project should be environmental sustainability, including the production of renewable energy by small hydro. This is just a question of highlighting certain aspects which may not otherwise be regarded as the main topic.

The extract given above is the outcome of several examples. Some of them will be described:

Example 1: Prioritising flood protection along a certain reach of river Traisen

In the river reach there were two old fixed weirs made of stone providing the water for two 80 years old SHPs, running at low efficiency. The area around is dominated by traditional
industry (Owners of the plants) and continuously increasing settlement in single houses. That makes the question on flood protection more and more relevant. With the mental municipal assistance the idea of a large flood protection project was born. Within the project it was necessary to lower the fixed crest of the weirs and replace them by flexible rubber dams. Another part of the project – financed by the operating industry- was the enlargement and complete modernisation of the power plants.

**Example 2:** Prioritising the authentic rehabilitation of an historical double flap gate.

In the upper course of river Ybbs one of the last double flap gates in Austria exists. For static but also operational reasons it was necessary to do some repair work. On the other hand this kind of double flap gate got historical value and the operating company decided to preserve the old structure. Within the restoration it was possible to realise a slight increase of the top water level, to reduce the water losses and finally to increase the rated discharge according to the hydraulic capability of the penstock. All together the rehabilitation allowed for an increase of power as well as production. The preservation of the historical weir can easily be used for PR work of the company.

**Example 3:** Prioritising the ecological functioning of a diversion reach.

Along the river Schwarzache in Tirol there are several SHPs. Built some decades ago the weirs have not been equipped with fish bypassing systems and there is no residual flow to be given into the diversion reach. One of these plants became subject of modernisation and uprating. According to recent knowledge and aiming at a better situation for fish a comprehensive study has been elaborated. Although the license for operation is valid until 2024 the owner proposed to deliver some environmental flow into the diversion reach and to built a new fish bypassing system at the weir. Along with these ecological improvements the losses at the weir has been reduced and the rated discharge will be increased significantly by installing a second turbine in the power house.

**2.1.2 Synergies and multipurpose plants**

Hydropower, in fact, does not “consume” the water that drives the turbines like taking drinking water or water for industrial processing. The water driving the turbines remains available for various other issues essential for human subsistence. Theses issues can be divided into “uses” and “protection”.

Issues of protection can be:

- prevention or mitigation of floods
- prevention or mitigation of droughts
- protection of the environment
- protection of riparian areas
Issues of uses can be:

- irrigation
- supply of water for domestic, municipal and industrial use
- improvement of conditions for navigation
- improvement of conditions for fishing
- improvement of tourism and leisure activities.

Even if the power plant in some cases pays for the facilities required for developing other water uses, this aspect is quite attractive.

The traditional way of designing and engineering aims at the main target of the project, while minimizing any negative impacts or compensating them if they cannot be avoided. This is the conservative way to proceed in the fundamental sense of the word. Thinking the other way round means to aim at the main target but also to alter conditions which are not primarily necessary, but likely to be in the interests of other people.

For example: the traditional way aims to maintain the current (recent) degree of flood protection. Any open-minded engineer may, however, decide between either an improvement in protection, or the creation of a wetland area. Both of these options are much better than the conservative solution, because other people and other interests are addressed and they may become partners in the enlarged project.

A wide range of potential synergies and multipurpose ideas exist, such as:

- Installation of small hydro plants within drinking water supply systems;
  (interesting mainly but not exclusively in Austria and Switzerland)
- Installation within irrigation systems;
  (interesting mainly but not exclusively in Italy and Spain)
- Installation within wastewater treatment plants;
  (example: waste water treatment plant Vienna)
- Installation within cooling water systems;
- implementing recreational infrastructure;(example: HPP Dorfmühle)
- Improvement in ecological performance;
- Improvement of flood protection;
- Inclusion of traffic demands; (HPP Deutenham)
- providing measures to stabilize groundwater level.

In many cases, the construction of multipurpose plants will result in a sharing of costs, of risk and of responsibilities.
2.1.3 Combined energy production and consumption concepts (PCC)

The energy produced by small plants is generally fed back into the grid, with guaranteed and quite acceptable tariffs being obtained. This will not provide any additional partners. It sounds better to complement production by direct consumption. The latter can be a manufacturing plant, public buildings, a whole village or district, or at least a block of flats. Depending on the respective tariff structure, such systems must be optimized to gather advantages for both the producer and the consumer. In the case of industrial units, sometimes the low price to get public energy avoids such PCCs. If it works, the effect on the public is very high, in relation to employment, identification, the ‘green power image’, and so on.

Example:

In hundreds of cases in Europe SHPs has been built along the development of industry in the first half of the 20th century. Industry has been modernised and SHP lost its essential value it had at the very beginning. The plants get old and badly maintained and nobody felt responsible. Together with the philosophy of concentrating on core business many plants got abandoned. This was the case at a certain plant in Styria. About six years ago a private investor bought the old plant producing 1,3 GWh/a. They did a lot of renovation and modernisation work and finally started up again producing about 2 GWh/a. The industry was very much interested in getting the electricity directly to cover some 60% of their total electricity demand. The plant owner and operator and the representative of the industry agreed in the price for the kWh delivered, which was lower than the industry has to pay by buying from the grid but still higher than the tariff the operator can get from the grid. An excellent example for a win-win situation.

2.1.4 Multi-resource concepts

Multi-resource concepts mean to combine different sources of renewable energy (RE) on local level, probably within one company or at one common location. Possible partners may be windpower, photovoltaics, biomass or even others. The availability of the resources mentioned is individual and different. A multi-resource concept may close gaps of production or at least smoothen the fluctuations. Small hydro is reliable, predictable and highly available. Wind and PV, which are among the leaders as far as the green image is concerned, are slightly lacking in these features.

Biomass or geothermal energy, however, have high availability. Any multi-resource concept will either strengthen the green image per se, or do so by improving the overall availability. Such a concept does not necessarily have to achieve excellent technical values. Even some attempt counts in terms of public image.

The ‘green image’ (a very powerful public feature) of different sources of RE is undoubtedly resource-specific and quite different. In a ranking of all renewables the position of small hydro is not the best. A partnership will thus become an advantage.
Combining hydropower or general RE with coal or gas is not primarily recommended because of the disputable advantage seen from the RE point of view. Such a concept may reduce the value of RE and increase those of non-renewal energy sources.

2.1.5 Green image, environmental audits, sustainability check

Another technical solution is to gain an environmental audit, a green certification or to pass a sustainability check to prove that the plant is designed and operated in a way preserving the basic features of the ecological integrity of the river system.

In some cases or systems that kind of certificates are accepted as a basis for the certification of the electricity produced. Switzerland as well as Austria is issuing these kinds of certificates and the acceptance confirms the idea behind.

2.2 Operational approaches

Engineering is a challenging job. The end of the initial design process usually represents the start of an even more exiting and unpredictable phase – the phase of getting the license, the phase of negotiations, the phase of construction works. In very few cases there is no need for redesign, alteration or adjustment to meet altered framework conditions. The most important qualifications and requirements are besides technical excellence: social competence, flexibility, persuasive power and authenticity. All these aspects reflect a more general and open-minded attitude in design and engineering. Some examples may illustrate the approach:

2.2.1 Flexibility in design

A complex engineering process has to be variable on a time axis. The variability may be based on alteration of any of the following:

- Ecological knowledge;
- Economic conditions;
- Various other interests;
- Political will;
- Availability of technical solutions.

In general, flexibility in design means the ability to face and cope with new demands. To meet that challenge, the engineer has to understand the project completely and precisely in all its details so as to be able to react exactly to any alteration, without changing contents of the project where changes are not necessary.

2.2.2 Design in the construction phase

Although a plan and a technical report should be the basis of the project implementation, that principle has a certain limit. With respect to the theory presented in Section 1.2.1, the design
during the construction phase can be understood as a continuation of the design during the planning phase.

Technical measures and precise engineering fit together quite well. But environmental measures will sometimes not be able to meet the demands of technical precision. The result of ecological measures, expressed by the so-called ecological function, is based much more on individual adjustment during construction than on a precise drawing or design. Consequently, a reasonable part of the finally successful environmental design can only be done during the construction phase.

The design provides just the framework, the target, the principles and the tools. In reality, this procedure requires very close cooperation between the engineer and the executing staff.

2.2.3 Mental preparation

Within the engineering procedure a good and successful project is based on two main pillars:

- Excellence in content and design;
- The conviction that the project is the best possible.

Both facts are decisive in defending a project in any approval procedure or participatory process. There must not be any doubt in the heart of the engineer that the implementation of the project is an important step in achieving a sustainable development. In this case, other people will not only understand, but also appreciate the quality of the project.

2.3 Involvement

From a general point of view the first step is to identify who is really involved by the project and what are the interests. Generally it is possible to distinguish between local inhabitants, who want to protect their own interest, the local enterprises, who are interested in working opportunities, the research organisations and/or universities, who can be involved from a scientific point of view and finally representatives of the government but also non-governmental organizations. Each of these bodies mentioned is animated by different kind of interest, which should be firstly identified and precisely defined.

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Each group tries to defend its own interest. According to this, the fear of each group is different.
As mentioned before, the basis of any solution has to be a correct project seen from the technical and engineering point of view. To give an example: a certain hydropower project will increase the water level for optimising the size of the plant. Naturally people living near the river will become anxious believing that in case of floods they will be endangered much more than previously. The correct calculation is just the first step – to convince the people and make them believe, that the calculation is correct is the second and much more difficult step. The levels where one is acting are different and of course the solutions will be different. For example, to preserve the private rights and interests of a sportive association a real cooperation and a deep dialogue is necessary to find the compromises which can satisfy every part. This, obviously, provides a preliminary spread of information, planning meetings and the flexibility of the engineering, mentioned before.

Any positive public opinion assumes at least a certain amount of public knowledge. Managing a project involves providing that information in the quality and form required. To gain this certain “quality” needs the cooperation with non-experts like the final consumers of the information. It has to be simple and clear using pictures of everyday life.

The second reason for public involvement is the widely spread human aversion towards any new idea. Offering ideas progressively in small portions will reduce resistance, because people identify certain aspects as already known. To involve people will put a new value on an individual project, and make it more of a public one. Of course, this involves some risks, but the positive effect usually dominates.
2.3.1 Involvement of governmental representatives

Within the regular approval procedure, a group of governmental representatives will review and evaluate the project. Traditionally, this group is given details of the project in its final state. Respecting social concerns, it is recommended to contact these representatives at certain stages of the project as follows:

- 15% feasibility study;
- 35% general design;
- 70% detailed design; and,
- 90% before completion.

The level of interaction should be high because of the expertise of the governmental representatives. Consequently they are more or less forced to participate in the engineering process by having their opinion or their expertise sought for certain solutions. The more familiar they get with the project, the greater the mental identification with the project will be. Nobody will argue against his own ideas.

2.3.2 Participation in the engineering procedure

In the past, several projects have failed as a result of local public resistance. When analysing this resistance, it seems that the main reason was the holding back of any information about the project. If people feel ignored, they may also be suspicious that they are being tricked. The content of the project, once transmitted to them, is usually not the major barrier.

In the context of development programs, participation can be defined as “the process through which stakeholders influence and take part in decision making, in planning, in implementation, in monitoring and evaluation of programs and projects”. (Kaosa et al, 1998)

Participation is difficult to evaluate as there are no commonly accepted quantitative indicators. It is thus important to distinguish between different levels of participation. In their study about participation in the Mekong River Basin, Kaosa et al. (1998) describe four stages of participation: information gathering, information dissemination, consultation, and participation.


The following table describes seven stages of intensity of participation. There is no rule which stage should be applied under which conditions. According to experience the size of the project and its possible impact on society will be directly related to the intensity of participation.
How is it possible to divulge the scientific and technical information to common people? For sure there is need for documents, reviews and summaries explaining in a simple way the background and the fundamental aspects of the design. This direct involvement of people is a process which can be carried out effectively through a series of informational meetings and public hearings. During these meetings it is possible to urge the population in the decision making process.

Participation is, as described, much more than giving information and may have significant influence on the engineering contents of the scheme. The engineer should not principally resist other ideas but it is his job to evaluate new ideas and to check whether they can be implemented, modified or rejected.
2.3.3 Mediation in the implementation phase

If the great variety of other tools have either not been applied or could not lead to a final compromise and there is still resistance against a project, mediation is a well known and well proven tool to gain a good result.

Although ‘environmental mediation’ is a well known term, mediation is not limited to overcoming environmental barriers.

Mediation is a procedure to overcome any disagreement which has reached a stage where resolution would otherwise not be possible. It is carried out by a professional mediator, who must be neutral. The solution has to be found by the clients, and the participation is voluntary. The mediator simply conducts the process and provides the necessary structure.

A first and sometimes underestimated phase in mediation process is the selection of the participants. Generally it can be said that everybody having concerns should be included. In larger projects respectively conflicts the groups may become quite large and the process itself may get endangered to collapse. It sounds recommendable to decrease the number of participants by involving representatives of interest groups instead of involving the entire group. The representative has to be elected democratically.
Another important task is the distribution among the group. The group should reflect the real range of different opinions and interests in a balanced way. Otherwise it may become difficult to gain an accepted solution.

The mediation process needs time. It does not make sense to give time limits or to time pressure, because the solution has to grow slowly and in more or less small steps to get acceptance. Breaks between working meetings of one or more weeks will support the process and the final result. The persons involved must have time to make the intermediate results their own and representatives need time to communicate intermediate results to the groups they represent.

2.3.4 Public monitoring in the operation phase

For scientific purposes, monitoring is a well known process, carried out by the design team or some other scientific bodies necessarily related directly to the aspect to be monitored. It is important to provide public access to the results of the monitoring process. Professional monitoring has to done in case any kind of public monitoring seems to be impossible due to knowledge and experience. Even professional monitoring becomes public monitoring as long as the society or the concerned people trust the monitoring group and get reports on the results from them.

Direct public monitoring aims to prove that the results predicted within the project have been achieved in reality. Such public monitoring is based on very simple features and can be carried out in parallel with professional monitoring.

A quite successful approach is the participation of educational bodies such as schools.

One may ask why any efforts are considered useful after the implementation of a project. The simple answer is that the success of a project does not end after its construction. There remain a lot of open questions within the operation phase, indicating an urgent need for public identification with the power plant.

2.4 Ownership and identity

Identification is a kind of ‘magic word’ and can be achieved either by measures described in Section 1.3 or by real ownership. The share, of course, has some influence on the intensity of identification. In principle, even a very small percentage of ownership that guarantees a positive effect. It is the actual commitment which counts, and not the amount, depending on the individual economic situation.

Identification needs a ‘real’ object with which to identify. In former times, small hydro installations tended to be hidden away, to avoid resistance.

Resistance as well as identification are, to a certain degree, emotions and both require objects and symbols, simply serving as a focus to emerge and to grow.
2.4.1 Public ownership

Wind energy has demonstrated this concept from the very beginning and the mechanism works perfectly. To share ownership has at least three advantages:

- Excellent public interest;
- Shared risk;
- Shared investment.

It is not clear why there is very little experience in ownership-sharing models in the field of small hydro. There is in fact no reason.

There are many economic models and they can be applied in the case of small hydropower. However, the public ownership model needs an operational body, like a limited liability company. The everyday business is carried out by the company, production reports for the owners may be given monthly, and a general assembly can be convened annually. The number of participants will be limited by the funds needed and by the portion.

2.4.2 Public–private partnerships

A little bit different to the model above is that of public-private ownership. The portions are then not offered like a loan or a stock, but the partnership is the result of negotiations. That concept sometimes occurs when two or even more potential investors are interested in exploiting the same situation. The inclusion of a public body like a community will serve as a neutral partner, and will be able to unite the former competitors.

Those models are also applied when the total investment exceeds the potential of one single investor. A public partner will limit the risk and in most cases the operational responsibility remains in the hands of the primary investor.

Besides all the economic reasons, any inclusion of public bodies is likely to encourage public interest and identification with the plants.

2.4.3 Public identity

Ownership is usually an economic fact. But in addition, it may also become a mental concept which is far from the financial aspects. To become a subject of public identity can be regarded as the highest level of acceptance.

Some examples can be given to illustrate this. Some small hydro plant operators have installed a kind of museum within the powerhouse, showing old-fashioned equipment. Others show their collections of historic agricultural tools, or collections of local art.

One excellent idea is the painting of the powerhouse by local children. Another is the installation of an energy filling station for electrically driven cars.

Along a bike-track, a small hydro operator may consider offering drinks and snacks. For visitors interested in technical aspects, a screen could show the recent performance of the small hydro plant.
An educational exhibit for the public could offer a list of certain energy consumers in everyday life, with a calculation of the hours of operation with a typical day’s production of the small hydro plant.

There are many occasions in our society to celebrate the opening and the start up. The production of the first kWh renewable energy should be an excellent reason to invite all the people showing some interest. Such a ceremony offers also the opportunity to invite politicians and mass media. A positive reaction is most likely to be seen as a result.

3. Recommendation

The overview given in this brochure is certainly not complete. The aim of the author was not to produce a list of rules strictly to comply with but to describe the basic mechanisms and causalities, coloured by some examples. Reading this brochure should encourage to criticising conservative and old-fashioned standard on how to run a project and to react on upcoming challenges. Of course this principle must never imply the neglect of technical and economic criteria. They remain valid.

The way to find some new approaches is in principle quite simple and can be characterised by a few recommendations as follows:

- Discover advantages in disadvantages;
- Try to be able to say: this has never been done before;
- Believe in the incompleteness of well-known solutions
- Share all your expertise – the feedback will be exciting and creative;
- Ask laymen what they are thinking about your project
- Discuss your project with colleagues of completely different expertise
- Think and act in a multi-dimensional way in interdisciplinary groups.
- Adopt achievements in other disciplines

The target group of this brochure contains preferably engineers and project managers. Nevertheless it will be interesting for local politicians and for representatives of governmental bodies to learn more about a very complex social process to be carried out side by side with technical and economical steps of engineering.