Design for a Better Environment

Prof. Schaller UmweltConsult

SSF Ingenieure

Memberships

BAB – Professional Association of Freelance Architects and Structural Engineers | Bavarian Chamber of Engineers – Civil | BASt – Federal Highway Research Institute, Working Group Sustainability | BYAK – Bavarian Chamber of Architects | BDLA – Federation of German Landscape Architects | DBV – German Society for Concrete and Construction Technology | DVWG Berlin – German Society of Transport Sciences | DWA – German Association for Water, Wastewater and Waste | EMM – European Metropolitan Region Munich | FGSVI Cologne –Road and Transportation Research Association | FIDIC – International Federation of Consulting Engineers | Friends of Structural Engineering Tech. University Dresden | GfÖ – Ecological Society of Germany | IABSE – International Association for Bridge and Structural Engineering | IAI – International Alliance for Interoperability VBI – Association of Consulting Engineers | IALE – International Association for Landscape Ecology | IHK – Chamber of Commerce and Industry | VDEI – Association of German Railway Engineers | VDI – Association of German Engineers | VBI – German Association of Consulting Engineers | VSVI – Association of Road Construction and Traffic Engineers in Bavaria | VSVI – Association of Road Construction and Traffic Engineers in Berlin-Brandenburg | VSVI – Association of Road Construction and Traffic Engineers in Saxony-Anhalt

Committee memberships

Bavarian Chamber of Engineers – Civil | committee for cooperation and international activities | working group for innovations in civil engineering | committee for education | committee of salaried employees and civil engineers

Gemeinsamer Arbeitskreis Bahnbau der Ingenieurverbände (joint working group of engineering associations for railway construction) | VDEI – Working group for structural engineering

Content

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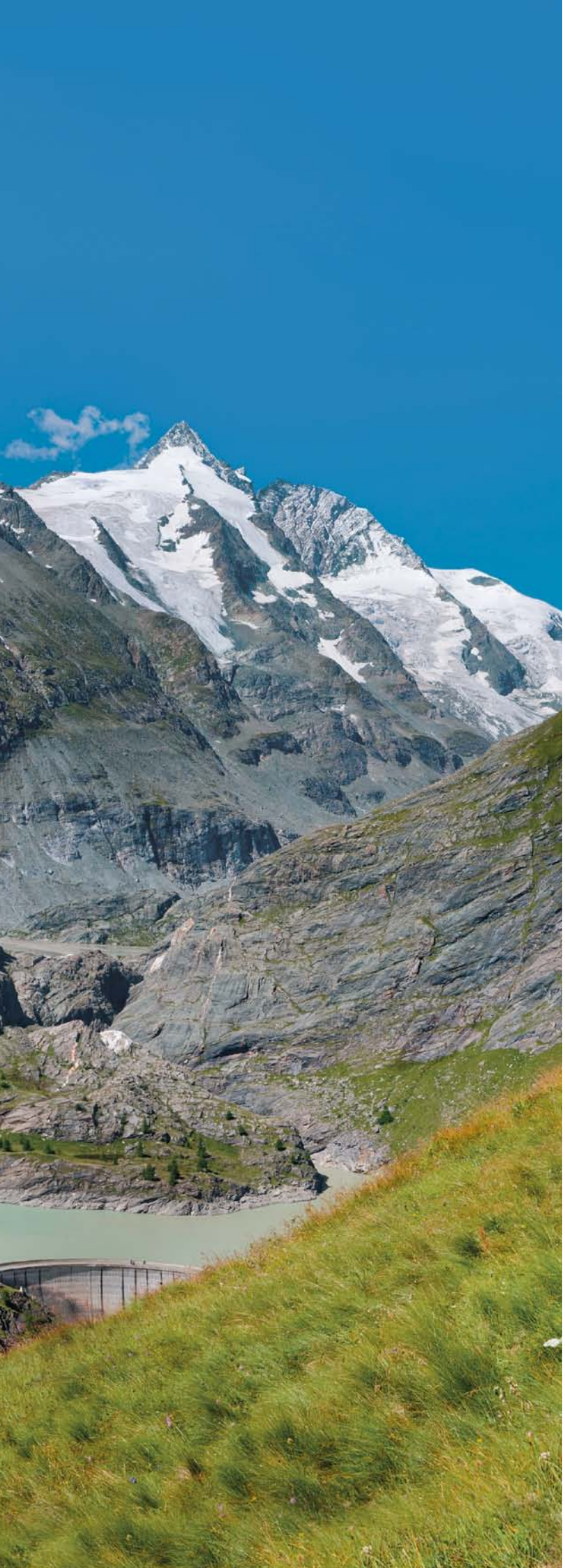


'As architects and engineers acting in all major areas our intellectual-creative activity is to deliver artistic, constructive, design services; we implement ideas, concepts and visions. We consider it to be a matter of course to find solutions directed at fulfilling high functionality, design and aesthetics, to implement them at the same time by saving material and resources and never to fail to adapt our design to the needs of our clients, to improve it technically or to include alternative, further developed or completely new ideas. We thus act independently from the excessively used notion of sustainability.

Our vocation is a cultural profession with a long tradition and of paramount important for the future. We have to be inventors and pioneers when it comes to finding answers to questions and tasks in view of preserving a liveable environment, guaranteeing a good life for all generations. The sustainable footprint of engineering services has therefore to become even more tangible…, and our engineers and architects at SSF Group work on this.'

Mooser Boden reservoir at Kitzsteinhorn, Hohe Tauern, Austria. The area is a highly sensitive ecosystem with outstanding beautiful landscape. Dam wall and reservoir are anthropogenic elements, yet hydropower serves to produce regenerative energy. Sustainable design is successful when technical, societal and environmental demands are carefully examined and weighed up against each other, and when all interest groups are included into this process.

Picture credit: Fotolia © leungchopan - Fotolia.com

Sustainability – more than just a dream

'Sustainable development aims at the improvement of well-being, which, by contrast to the model of unlimited growth, respects the preservation of viability of natural bases of life.' (Objectives for sustainable development, Munich 2005)

The realisation that the current way of life and economy cannot guarantee the well-being of humans on a long-term basis, even influences it significantly in a negative way, made 'Sustainability' become a key word. When a society, a city, a region or the fabrication of a product or construction is intended to be 'sustainable', a holistic consideration is needed in line with private sector and economy aspects as well as ethical, socio-cultural and ecological values. Moreover, a period of time has to be taken into account that includes all life phases of the project or object.

The traditional motive of an engineer or architect is to design and build a structure as perfect as possible – functionally and aesthetically. In contrast, there is the economic demand of low costs and high usability. The sustainability dialogue now brings social and environmental motives into the focus of reflections. We as architects and engineers understand it as a social task to implement the projects our clients entrust to us with much confidence as long-term functioning structures not only under aspects of design, technology, function and economy. We want them to fulfil – with regard to future repercussions – demands of ecological restrictions and of socio-cultural as well as socio-ethical evaluation criteria. We take the challenge on to ensure and design a viable and liveable environment for future generations.

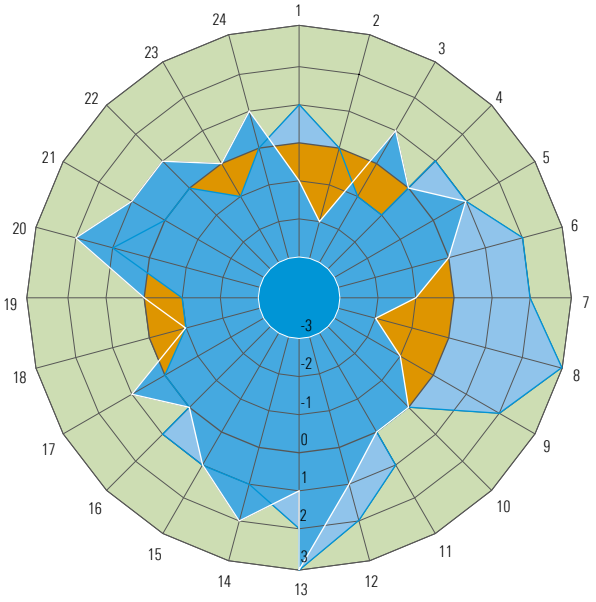
As a sustainable and socially responsible company we identify ourselves with the principles of corporate responsibility (code of conduct) and orientate ourselves voluntarily to the new ISO standard 26000 of Social Responsibility. SSF Group takes pride in including every person involved within our company into this code.
This prospectus is the result of intensive reflections and decisions regarding the subject of sustainable construction in the areas of building and transport infrastructure engineering, urban and landscape development. Each of these areas imposes different requirements and approaches and thus a diverse spectrum of services.

An intensively used city landscape in Hong Kong, China. The infrastructures allow highest possible efficiency of the flow of goods, services, information and people. From an aesthetic point of view, impressive perspectives are the result, yet needs of people, the residents, workers and vacationers need to be taken account of too.

Graphical synthesis of two different project impacts

1 Risks - local environment
2 Ecological impacts
3 Greenhouse potential – construction
4 Greenhouse potential – lifecycle
5 Greenhouse potential – traffic congestion - construction
6 Greenhouse potential – traffic congestion life cycle
7 Costs – construction
8 Costs – life cycle
9 Costs – traffic congestion
10 Costs – demolition
11 Changes of driving time
12 Changes of accidents
13 Changes of operational costs – route
14 Design of the structure
15 Integration - surroundings
16 Usability
17 Functionality
18 Operational optimisation
19 Noise protection
20 Structural quality
21 Quality of equipment
22 Renovation friendliness
23 Possibilities of demolition
24 Expansion

negative impacts
positive impacts



Sustainable design within SSF Group

From an overall concept to the detail

The global challenges of climate change, scarcity of resources, rapid urbanisation and demographic change require targeted thought processes, constant improvement of the already proven, accompanying creativity and last but not least the courage to think differently and to implement new ideas and visions. Thinking in paradigms and obdurate implementation of state-of-the-art technology will not advance us in any way.

Our competencies, experience and variety of reflections enable us to combine the best technological solutions with the necessary sustainability parameters so as to keep up with challenges and efforts presented by the built-up environment – form the overall concept to the detail.

Building sustainably means for us to design responsibly but also to act responsible beyond borders, interdisciplinarily within each individual specialisation. The people working on a project cooperate beyond the limits of their area of responsibility and discipline.

It is important to start early on and to begin at a high scale level, i. e. covering a wide area. Use of surfaces and potential of sites is always related to the quality of offers and accessibility, to networking of metropolises, regions and rural areas, to design of transport systems and to assessment and evaluation of impacts on environment, economy and society. Occupation of spaces, pollution of protected goods and aesthetic space quality are subject to specially considerations. For sustainable development of settlements, cities and infrastructure, the limits of constructional and infrastructural development have to be explored. In the framework of spatial resistance analyses and environmental impact analyses, durably tolerable pollutions of spaces and their protected goods are questioned. It is thus not only the individual object which has to be designed with regard to sustainability; moreover, a previous analysis of development potential and pollution limits at local (community), regional and national scale is particularly important.

Sustainable Design within Special Disciplines and in the Team

To reach a technical depth, essential for the evaluation of sustainability, architects and designers are needed, of whom a lot is demanded: technical knowledge and experience, high motivation to design and innovate, obviously a sense of quality, costs and environment, project management and communication skills, competent material and product knowledge. The companies belonging to the SSF Group employ highly qualified specialists. We invest constantly into further education and training of our staff. We take pride in appreciating each individual's performance and the cultivation of collegiate and respectful team work.
To enhance a holistic design process, numerous areas of specialisation have to be linked with each other and to be coordinated in a most optimum way. For this purpose SSF Ingenieure disposes of a network of architects and designers to foster interdisciplinary and international work. Sustainability implies also a fair and respectful dealing with everybody involved in the design process and construction execution.

New technologies, especially appropriate software taking on the management, distribution and optimisation of constructions, support sustainable design, construction and use of structures. BIM (Building Information Modelling) supports perfectly the design, use and maintenance of a structure. The three-dimensional project models of BIM register the data of a structure over its whole life cycle, hence optimising the life phases. During the design stage, all participants at the project access the BIM project model, making changes in the drawn model as well as the data package which are both directly available. Coordination is optimised, the risk of errors due to constant changes is minimised and newest cost and schedule data are retrievable at any time.

During the construction stage, the project models facilitate communication and coordination with production as the latest data and schedules, for example for material delivery or fabrication facilities, can be used. Construction processes and logistics on the construction site are digitally improved resulting in even more efficiency advantages.

Also during utilisation, BIM can be employed for example for operation, facility management, conversion due to changes of use or to save cost and energy by exchanging materials. The engineers at SSF have been working for years with the state-of-the-art technology and have further developed the BIM software.

Accessibility analyses, advance planning, aeroelastic stability calculation, apposite aesthetics and calm design, **alluvial dynamics, area development plans**, assessment of claims in course of construction, assessment of current state, authorisation to submit building documents, auxiliary construction planning, awards management, benefit/cost analysis, best practice on site, bills of quantities, buildability analysis, building controlling, **Building Information Modelling**, building optimisation, building physics verifications, building planning, top-level building planning, building logistics planning, building sequence planning, building site investigation and consulting, building supervision, business foundation consulting, **cartography, CEF continuous ecological functionality measures, certifications**, clear structuring of structural details, claim management, **climate protection concepts, compensation measures**, comprehensive dynamic calculations, concept development, conflict analyses, **conservation and development plans**, constant optimisation of constructional elements in view of economic efficiency, construction efficiency, construction technique development, contract management, coordination planning, cost-benefit analyses, cost controlling, cost management, detail planning, **DGNB certification digital elevation model**, discharge calculations, document management, documents for land development and plan approval procedures, draft design, due diligence, durability, dynamics, ecological cartography, energy-efficient constructions, energy-efficient design, **environmental assessment, environmental impact assessment, environmental monitoring**, execution planning, expert opinions, **expert's reports**, facility management, feasibility studies, fictional drafts, force flow oriented form and material selection, freeze stabilization, general planning, generation of documents for regional planning and planning approval procedures, generation of specifications and documents to international standards, generation of system specifications, **geographical information system ESRI-GIS**, green area planning, greenhouse potential analyses, **groundwater systems, Habitats Directive – compatibility analyses**, hydrological investigation and planning, implementation of quality assurance measures, improvement of operation costs, travel time, emissions and accidents, independent engineering, installation planning, interdisciplinary dialogue, interface management, inventory control, invitation to bid management, land planning, **landscape architecture, landscape conservation plans, landscape development, landscape framework plans, landscape planning, life cycle assessment, life cycle costs, location analyses open space photovoltaics, location analyses wind farms, location assessment**, material usage concepts, master planning, mechanical fracture analysis and verification of fatigue, minimisation of environmental impacts, execution, cost and schedule risks, multi-channel measurement record certification, **Natura 2000, nature protection**, noise emission calculations, noise protection analysis and design, nonlinear geotechnical FEM analysis, on-shore and off-shore wind power towers, **open-space concepts, open space plans**, operating concepts, optimised user functionality and flexibility, **outline concepts**, overhead cable on and off-switch during construction, **phytosociological cartography**, planning of building traffic, planning coordination, project development, project management, project steering, **protected natural resources**, public authorities management, **public relations**, regional planning, **renaturation**, renovation planning, repair planning, requirements analysis, **research and development projects, revitalisation concept**, risk analysis and assessment, robustness, room acoustics, spatial structure analysis, route planning, safety and health coordination, scheduling, seismic calculations, **service specifications**, serviceability, site management, site supervision in civil engineering, road and rail, settlement structure analyses, space utilisation planning, space structural analysis, space resistance planning, spatial resistance, special excavation planning, species protection, stability analysis and planning of embankments, dams and cliff overhangs, stability calculations and tests at international level, status capture, street grid modelling, structural analysis, structural engineering, structural examination, structural optimisations, structural physics certificates, successful integration into the surroundings, sustainability planning, surveys, technical equipment, tender assessment, **tender documents**, traffic analysis, traffic prognoses, traffic impact studies, transportation studies, tunnelling simulation, **urban structural concepts**, use of adequate materials and material combinations, user and functional logistics, utility management, value appraisal, value engineering, viability analysis and rating, vibration analysis, vibration calculations, urban development, use-withdrawal concept, **Water Framework Directive, water monitoring, wildlife conservation analyses**, works planning, **zoological cartography**

Sustainability of Building Engineering

Intelligent Buildings through Future-Efficient Solutions

Energy Efficiency in Building Engineering

In Germany around 40 % of energy is spent on heating, lighting and air-conditioning of buildings and on water heating. This causes 20 % of CO_2 emissions (Sustainability report of the German Ministry for Transport, Building and Urban Development, 2011).

The awareness of increasing greenhouse effects and the related ecological and economic consequences as well as the foreseeable constant cost increase of fossil fuels entail demanding aims of CO_2 reduction in the context of international and national climate protection. In the area of energy efficiency, Germany has assumed a leading position throughout the world. The integrated energy and climate programme (IEKP) of the Federal Government expands this position in the future. Goal of the programme is to reduce greenhouse gas emissions until 2020 by 40 % compared to 1990. Highest sustainability standards have to be applied to reach this goal. An ecologically sustainable building technology as well as facade technology oriented towards energy efficiency, in combination with an optimised energy production for heating and cooling of building bodies – ideally supplied by renewable energies – are of decisive importance to reach the defined goal.

Holistic/Integrative Design

As buildings are generally used over a long period of time, their whole life cycle, beginning with construction, operation and use, renovation and finally demolition, should be completely represented already during design and then be analysed and opti-

Picture credit: Lang Hugger Rampp GmbH Architekten

Picture credit: Klaus Leidorf

mised in view of sustainability. The aim of sustainable design in building engineering is to achieve high quality for an intelligent, energy-efficient building with smallest possible impacts on the environment.

The essential aspects of sustainable building comprise six fields:

- location
- ecology
- economy
- functional and socio-cultural properties
- technology
- processes

An old industrial site in the Yangpu District in Shanghai (left) is to be completely renovated, modernised and expanded in view of its utilization as multi-functional event centre. In the tense atmosphere of a constantly growing megacity experiencing demolition and new building, and of a fast growing society, the conservation of old buildings and the careful revitalisation of a city quarter stands for new quality in the urban context.
Project of SSF Ingenieure together with architects Lang Hugger Rampp: basic evaluation, preliminary and draft design

BMW Welt in Munich (right) is the event and delivery centre of BMW. With futuristic architecture, a spectacular load-bearing shell, innovative interior design and a variety of expositions and events, BMW Welt combines technology and design with lifestyle and culture. And with more than 2 million visitors per year it succeeds in creating urban space for meeting and dialogue. On the roof of BMW Welt is an 8,000 square metre solar power plant with 220,000 solar cells, which contributes with an output of 810 kWp significantly to the energy efficiency of the building of a gross volume of 532,000 m^3.
Project of SSF Ingenieure: architectural final design in cooperation with COOP Himmelb(l)au Vienna, complete structural engineering, all general planner services

Picture credit: Lang Hugger Rampp GmbH Architekten

The location analysis is the first step of sustainability considerations of a building and is prerequisite for a resource-friendly networking.
The impacts on the environment include especially an ecological balance, the protection of resources by optimising the use of construction materials and products, the minimisation of media use (heating, electricity, water, sewage) and the environmental pollution of water cycles, soil, air and climate.

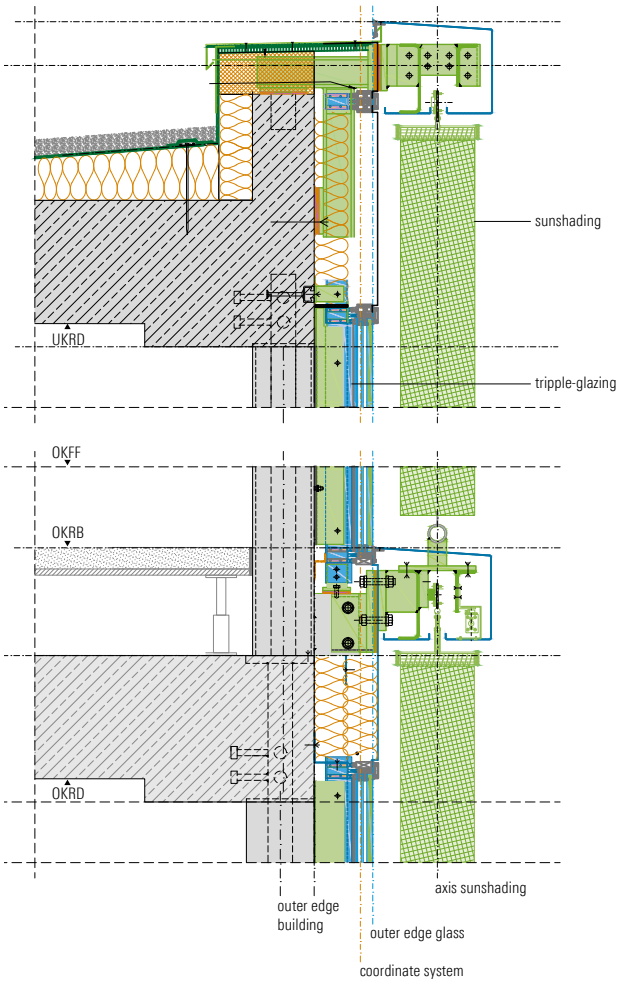
In the context of the economic dimension of sustainability, beyond construction costs, the entire use and life cycle costs are taken into consideration. As follow-up costs can exceed actual construction costs, enormous savings can be identified by life cycle cost analyses.
Questions of aesthetics and design as well as aspects of health protection, interior room climate and comfort are particularly important for the socio-cultural and functional dimension of sustainability.

Technological considerations in view of an intelligent building encompass the following factors:

- building concept (function, building form, orientation)
- adapted room programme (entry situation, flexibility of use such as third-party use or change of use)
- innovative, resource-friendly load-bearing structure (formation of structural details, processing, possibilities of changes, demolition possibilities)
- constructional design (materials, acoustic and visual comfort)
- building shell with intelligent facade technology adapted to the energy balance
- building technology adapted to the users (heating and cooling systems, interior room climate, thermal comfort)
- safety concept (fire protection, accessibility)
- building physics (heat and noise protection, energy consumption for construction, demolition and maintenance)
- renovation concept (putting into services of facilities, cleaning, maintenance)

ZAE – Energy Efficiency Centre, Wurzburg (left): The research building 'Energy Efficiency Centre' of the Centre for Applied Energy Research (ZAE) uses innovative, prototypical and efficient construction materials, systems and technologies in order to verify by means of example their application in the sense of resource-friendly construction methods within the building stock as well as for new buildings, to demonstrate them and to subject them to monitoring. The form of the building reflects the innovative goals of ZAE and is a showpiece with its formal and material appearance. The planned textile construction type of the Energy Efficiency Centre will contribute essentially to increasing the energy efficiency of the designed new building. Conceptualized as multi-layer building shell, the roof creates an intermediate climate zone, reducing heat loss as well as limiting the requirements of weather resistance of the thermally efficient layers used for the building's exterior façade. The energy input and supply of the area with daylight can be exactly influenced by a tailor-made adaptation of transmission parameters of the applied membranes. The use of environmentally friendly and primary energetic district heating from combined heat and power schemes used for heating, water heating and cooling of the building by sorption-assisted cooling technology is at the core of the building's energy supply.
Project of SSF Ingenieure together with Lang Hugger Rampp GmbH Architects: draft design, project management and structural engineering

Media house Schwäbischer Verlag, Ravensburg (right): The new building of Schwäbischer Verlag units the different functions of the publishing house in a subdivided multi-part building. In the city centre of Ravensburg, within a high-quality yet functional architecture, contemporary work space will be created with open, flexible working rooms to enhance communication. The concept focuses on energetic building, the harmonisation of load-bearing structure and thermally efficient layers as well as on careful technical-structural conception of structural details, especially of facade and shading. The building, to be completed by 2012, has already been awarded a pre-certificate in silver of the DGNB.
Project of SSF Ingenieure together with architects Weil Arets: general planning, project supervision, high-quality architecture



The optimisation of the entire system – the sum of all building-physical, structural, architectural, etc. components – should be perceived as a process which also serves risk minimization.With regard to pure structural engineering of a building, sustainability is defined far and foremost by intelligent load-bearing structures that are structurally optimised for the whole life cycle in view of open-space, unhindered use and maximum flexibility in consideration of following change of use, and that meet in an economically optimum way the requirements of high-standard architecture and design, especially of building and facade technology.

In consideration of ecological aspects, sustainability of structural engineering is clearly marked by optimised load-bearing structures and the application of materials and material combinations whose characteristics are highly efficient in view of external influences and resource protection. Decisive for continuously energetic building is the exact adjustment of the structure and the thermally effective component layers (base slab, ceilings, walls, external facade, shading, transmission, etc.) and the careful technical-structural formation of details to avoid thermal heat bridges and disadvantageous building-physical conditions.

Within the SSF Group, engineers, architects, landscape architects, environmental planners and geologists work together to guarantee integral solutions and technically well-developed design for sustainable projects. When designing and implementing buildings, SSF has been working efficiently for many years with architects and specialist designers.

We act as general planner for complex projects in order to coordinate all interdisciplinary interfaces.

Sustainable design means for us to optimise technically and economically our design solutions, despite alternating boundary conditions during the use of a structure. Our aims remain to organize each and every project as efficiently and proficiently as possible.

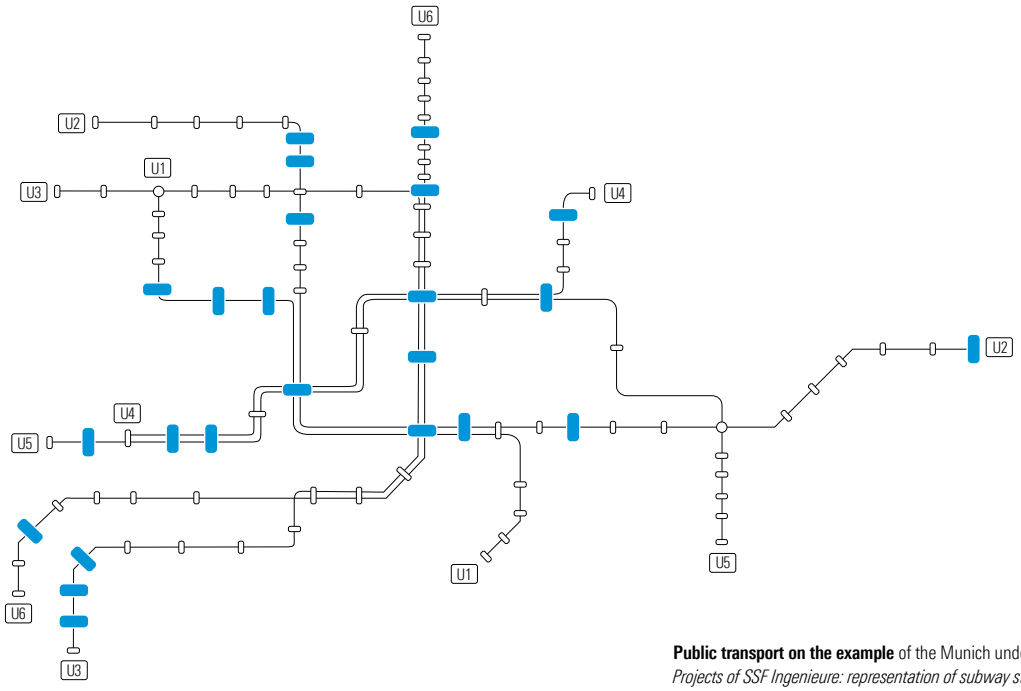
Sustainability of Transport Infrastructure Engineering

Transport infrastructure is the backbone of our modern society. Roads, railways as well as air and water ways guarantee nowadays mobility and make social and economic development possible. It is a task beyond generations to maintain the transport network, which is so important for our existence, and to develop the related transport offer in such a way that the design of future mobility becomes possible and guaranteed. An overall consideration of sustainability enables us to evaluate infrastructure measures future-efficiently or at least to anticipate them. Negative influences can be diminished by applying pertinent evaluation criteria within analytical structures. In this way we assure a best possible transport network for future generations providing them with highest use and lowest internal and external costs possible.

Recent experience shows that large-scale construction projects are often not accepted by the population as confidence is missing in the decision-makers' ability to make impartial choices. With objective considerations of sustainability, mostly neutral assessments can be established, resulting in high transparency. This assessment oriented towards the needs of society as a whole increases the possibility to find consensuses amongst persons affected and interest groups; thus creating the possibility to accompany economically sustainable and reasonable transport projects fast and cost-efficiently throughout the approval procedures.

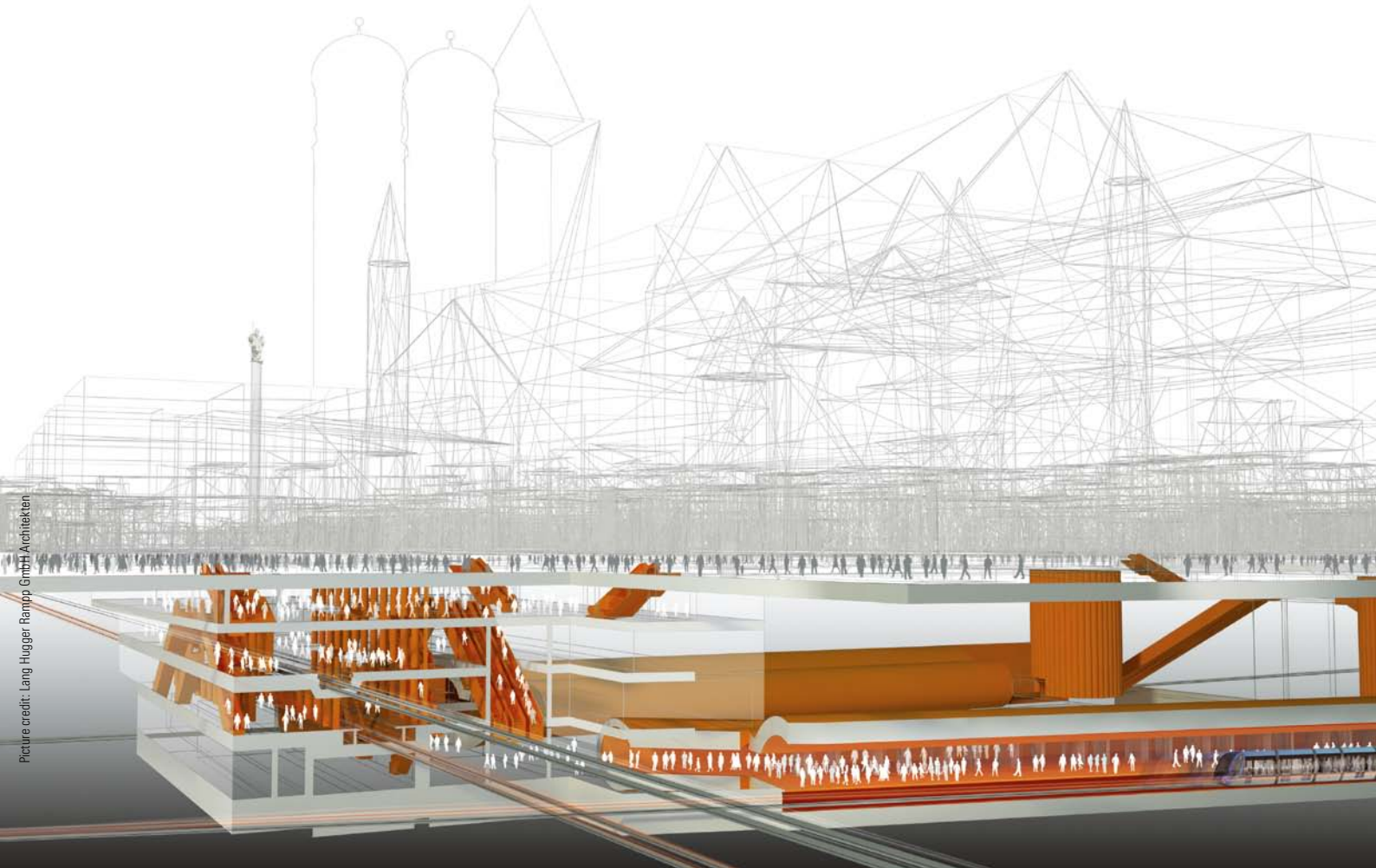
System development Light-Weighed Noise Barriers (right above): Noise is an environmental stress to be taken seriously. It can impact directly or indirectly the well-being and health of individuals. Anti-noise measures have hence become one of the most significant aspects of environmental protection. In our densely populated areas the expansion of transport infrastructure becomes more and more important. Anti-noise measure and the legal noise regulations are especially in conurbation areas decisive for the enforceability of such projects. In addition to the major importance of noise avoidance, special attention has to be given to the elaboration of individual, noise-technological solutions at traffic routes in densely built-up area as well as to the development of technically improved and sustainable, economically optimised solutions. The development of the system 'Light-Weighed Noise Barrier' entails, due to its conception, economic savings during construction as well as operation compared to conventional barriers, yet achieves almost the same levels of noise reduction. Especially within conurbations, this solution is preferable as sustainable noise control because of numerous other advantages compared to conventional solutions. The road continues without interruption or restriction within the structure with spacious clearance and infiltrating daylight. From the outside the light-weighed barrier is not perceived as massive sight barrier because of its light and modular appearance. The structure offers the possibility of extensive roof planting and thus ecological advantages, which even leads to acceptance in adjacent built-up areas. Ventilation strips provide airing and smoke extraction without additional technical installations.
Project of SSF Ingenieure: concept and system development

Underground station, Munich (right below): The management of dynamically increasing traffic in conurbation areas and megacities is only feasible with a sustainable transport planning, meeting the needs of each generation, adapted to an optimised and progressive transport system. Tunnel construction is of special importance particularly in view of environmentally friendly and space-saving construction in cities, conurbation areas and under topographically difficult boundary conditions. The Football World Cup 2006 and the new construction of the stadium Allianz Arena required a capacity increase and thus expansion of the underground station Marienplatz in Munich. Two additional relief tunnels widen the existing platforms to double their surface and decongest passenger flows of subway and regional train traffic. The old and new platform tunnels are connected to each other at eleven points. The expansion tunnels were drilled using ground freezing method to protect the groundwater. Tunnel lengths 98 m/103 m, depth of launching pit 30 m, excavation cross section 55 m² each.
Project of SSF Ingenieure: alternative offer ground freezing, complete final design; Engineering Award 2005 by the Bavarian Chamber of Engineers – Civil



Public transport on the example of the Munich underground network
Projects of SSF Ingenieure: representation of subway stations involving services of SSF Ingenieure

Picture credit: bit-better Visualisierung



Picture credit: Lang Hugger Rampp GmbH Architekten

Sustainability Evaluation

The sustainability evaluation of transport infrastructure constructions requires to understand all influences and effects of the project as a whole and to evaluate them. Three pillars of sustainability have to be analysed in detail: ecology, economy and socio-cultural matters.

These fields can then be divided in sub-aspects. Different qualitative and quantitative approaches are pursued. Decisive is to take into consideration all areas with a comprehensive and integral approach so that they become transparent with multi-criteria evaluation and to assess them in a synthesis and weighing the criteria up against each other.

The sustainability evaluation of transport infrastructure can be split into two essentially different areas: linear construction (e. g. corridors and alignment of transport routes) and punctual, single transport structures (e. g. bridges, tunnels).

For both categories the evaluation aims are fundamentally different as well as the evaluation methods. In addition to finding the adequate corridor, the analysis of different alignment variants is important.

Picture credits: SSF Ingenieure AG / Florian Schreiber Fotografie

To make a proper sustainable decision in view of realisation of transport routes, intensive interdisciplinary analyses are to be carried out based on the following evaluation aspects:

- space-structural aspects
- environment-related aspects
- geological and hydrological aspects
- transport and transport-economic aspects
- road planning aspects
- aspects of civil engineering/tunnel construction

in consideration of:

- aspects of transport efficiency by pre-selection of corridors with variants of connections to the existing road network

To identify and describe qualitatively and quantitatively the effects aimed at with the implementation of a transport route, a catalogue of evaluation criteria is generally established. These criteria are categorised in design/alignment, traffic development, transport economics, environment and spatial structure. In Germany, for example, the formalised procedure for evaluation and ranking as per working paper No. 58 (issue 2002) of Forschungsgesellschaft für Straßen- und Verkehrswesen e.V. (FGSV) [road and transport research association] in Cologne is available.

Furthermore, costs arising from restraints and hindrances on the transport route have to be taken into account. These costs can be calculated by consulting, for example, the recommendations for economic efficiency analysis of roads EWS published by FGSV and the general circular ARS7/1990 ('Tenable additional costs') of the German Ministry of Transport, Building and Urban Development. EWS serves as foundation for an economic evaluation and a comparison of variants based on uniform principles. Key aspect is the evaluation and analysis of the benefits of a project (cost/benefit).

Investment costs and running costs with:

- changes of operational costs (itinerary, time, speed)
- changes of travelling expenses (economic use by time savings)
- changes of accidents (constructional state and traffic situation influence accidents)

Single structures are however evaluated in view of type of load-bearing structure, resource-friendly materials and optimisation of execution.

The selected construction method influences the effects on the surroundings of the structure decisively. For example ARS7/1990 treats the acceleration of construction sites on German motor-

ways with high traffic density or with high susceptibility to obstructions so as to improve traffic flow and safety. Constructions on these routes are to be planned with short execution periods so as to prevent economic damages due to congestions.

ARS7/1990 submits further shortenings of construction time to competition and makes them an additional criterion for the award of construction contracts. Shorter construction periods and procedures with positive influences on traffic management are factors for socio-economic reflections.

Economically efficient in the sense of an economic consideration (without fundamental integral sustainability) is a structure not only through low production costs, but also by being the most cost-saving solution over the whole life cycle bearing in mind all arising costs for: construction, for maintenance, for preservation, for renovation, for demolition at the end of the life cycle.

A first evaluation tool is, for example, the guideline for implementation of economic efficiency analyses in the framework of renovation/renewal of road bridges Ri-Wi-Brü of the German Ministry of Transport, Building and Urban Development.

Crossing of the Strelasund, highway B-96-n feeder Stralsund/ island of Rügen (left) The requirements of increasing traffic on the island of Rügen and in Meckelnburg-Western Pomerania and the region's development are met with the construction of an around 55 km long feeder road, connected to the coastal motorway A20 and thus to the German and European long distance road network. The Rügen feeder and the new bridge, the second crossing of the Strelasund, from the mainland to Germany's largest island are extremely important for tourism as well as the ports of Sassnitz/Mukran and Stralsund. Main part of the in total 4.7 kilometres long 2nd crossing between the town bypass of Stralsund and intersection Altefähr is the around 2.8 kilometres long bridge section called Rügen Bridge. This section is composed of six individual structures, which are connected by similar design elements to form one aesthetic unit. A master piece of engineering technology is the 583 m long cable-stayed bridge spanning the Ziegelgraben with a clearance height of 42 meters for ship traffic and a span width of 198 m. The impressive 128 meter high pylon of the Ziegelgraben bridge is the architectural highlight of the bridge ensemble, which as new 'gate to Rügen' has become a landmark of the Hanseatic town of Strelasund. High architectural quality, expressing itself through careful integration of the bridge into the surroundings as well as through very precise details of the individual units, shows the determination to assume socio-cultural responsibility across generations.
Project of SSF Ingenieure in working group with other offices: final design of structural engineering, draft design partially

Motorway A9, junction Neufahrn, structure BW 13/02s fly-over (right) Motorway junction Neufahrn connects motorways A9 Nuremberg – Munich and A92 Munich – Deggendorf north of Munich. The average daily traffic volume in direction Munich on the A92 amounts currently to 25,000 vehicles/24h and is predicted to increase by more than 50 % to 38,000 vehicles/24h by 2020. To augment efficiency of this important traffic hub between Munich and the Airport and to durably maintain and improve traffic safety and flow, traffic layout and alignment have been optimised at the junction and a direct ramp as fly-over structure in direction Munich has been built.
Project of SSF Ingenieure: project planning and structural engineering of the fly-over structure, two additional bridges constructed while traffic flow was maintained

Integral design of a structure means:

- clear load-bearing structure, force flow oriented form and material choice
- clear formation of constructional details
- successful integration into the surroundings
- appropriate aesthetics and calm design
- durability, robustness and serviceability
- consideration of economic effects of construction, operation and demolition of the structure (investment costs, operational costs, costs for demolition, total capitalization)
- consideration of economic effects on users during construction and maintenance of the structure (costs due to congestions, longer driving times, increase of operational costs, etc.)
- consideration of greenhouse potential during construction, maintenance and demolition as sustainability criterion.

As first evaluation scales for engineering structures the following sub-criteria can be defined:

Ecological Quality

risks for local environment, greenhouse potential/construction, greenhouse potential/life cycle – maintenance – renovation – demolition, greenhouse potential due to congestions during construction as well as renovation/maintenance measures during the life cycle

Economic Quality

costs of construction (incl. CO_2 E – costs for main construction material), costs of life cycle – maintenance – renovation – demolition, external costs due to congestions during construction as well as renovation/maintenance measures during the life cycle

Socio-Cultural Quality

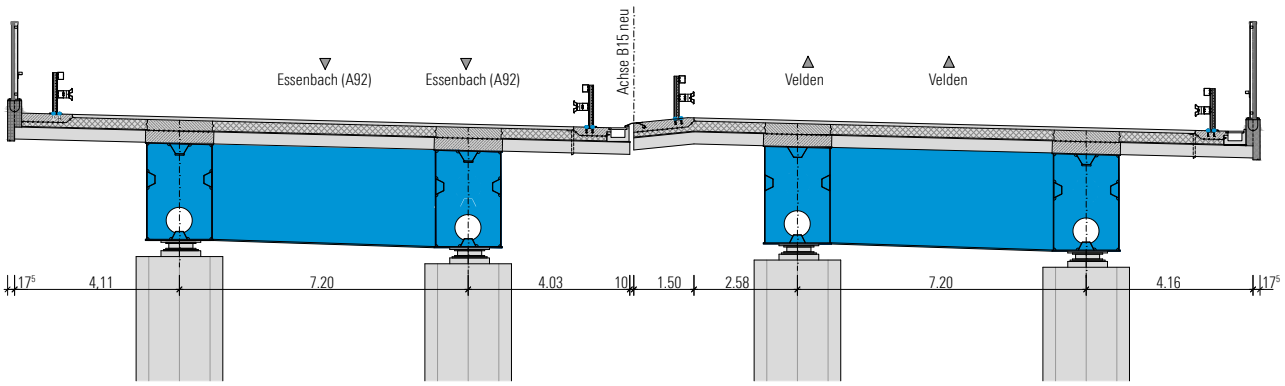
design of structure and its integration in the surroundings, user-friendliness

Technical Quality

structural quality, renovation and maintenance friendliness, possibilities of demolition, recycling and demounting

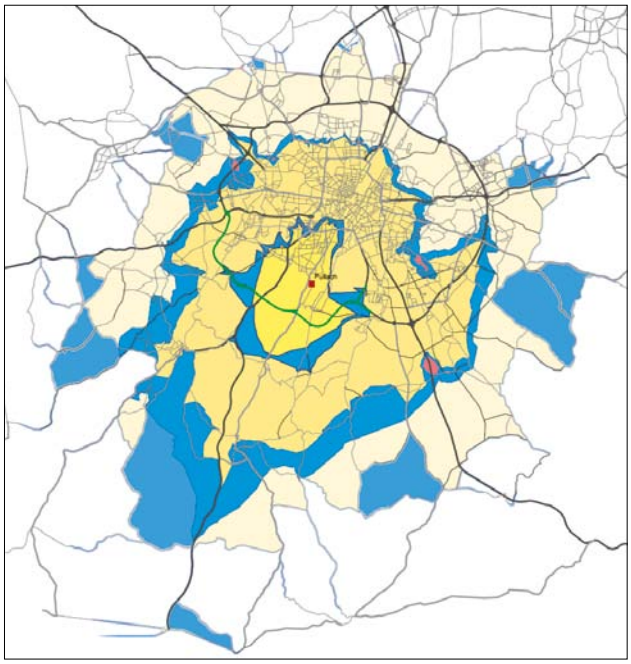
Generally, the earlier sustainability criteria are integrated into the design process, the higher are possibilities of control in view of an integral consideration. When a sustainability evaluation is already integrated into the preliminary design, the aim of an ideal or at least sustainably tolerable solution can be implemented and the whole project be optimised towards this aim. A sustainability analysis applied during final design will only lead to rudimentary improvements. In contrast to single building engineering projects, in transport infrastructure engineering the actual transport structure, with the exception of tunnels equipped with operational technology, is not that decisive in view of the project's sustainability. It is rather the secondary effect which defines overall quality; so that a congestion scenario caused by unfavourably planned construction or renovation procedures can negatively influence a transport project which in itself has been design sustainably.

'Design of a road bridge in accordance with holistic evaluation criteria': To sensitize for and reinforce the subject of sustainability in the design of bridge structures, the Bavarian Chamber of Engineers – Civil launched an idea competition. The competition aimed at the development of a bridge concept which, in addition to traditional quality parameters of optimum designs, satisfies economic, socio-cultural and last but not least ecological evaluation criteria over the whole life cycle in consideration of sustainability for the next generation and high economic benefits. The design distinguishes itself by the development of a modular construction system, whose implementation entails no or only minimal risks for the local environment. The careful construction method with optimum prefabrication of the bridge superstructure reduces the bridge's impacts on the environment to a minimum (local flora and fauna as well as global climate change) and involves economic advantages. The targeted use of materials or material combinations, which are applied in a highly efficient, resource-friendly way due to their characteristics towards external influences, leads moreover to favourable CO_2 E values. *Project of SSF Ingenieure: 2nd prize in the idea competition of the Bavarian Chamber of Engineers – Civil*



Motorway ring road, section south, Feasibility study of gap closing A99 (right): The Munich motorway ring has not yet been closed in the south west. Due to this, the city's inner urban ring road is subjected to enormous traffic in the southern part, leading to consequent unfavourable impacts on the urban environment. The aim of the feasibility study consisted in examining the need and feasibility of a southern motorway ring for Munich in the framework of an unbiased analysis demonstrating potential alignment corridors. In addition to effects from traffic, traffic economy and road planning, geological and hydrogeological, spatial-structural and of course environmental impacts of such a measure have been demonstrated by variant spectrums and numerous evaluation criteria. Of priority was a durable, high traffic efficiency with consequences as sustainable and positive as possible despite high susceptibility in the corridors. Comparison of alignment possibilities. Representation of accessibility differences on a variant example

Project of SSF Ingenieure in working group with other offices and designers, amongst them: Prof. Dr.-Ing. Gebhard Wulfhorst, Department for Urban Structure and Transport Planning, Technische Universität Munich



Comparison of alignment possibilities

Representation of accessibility differences on a variant example

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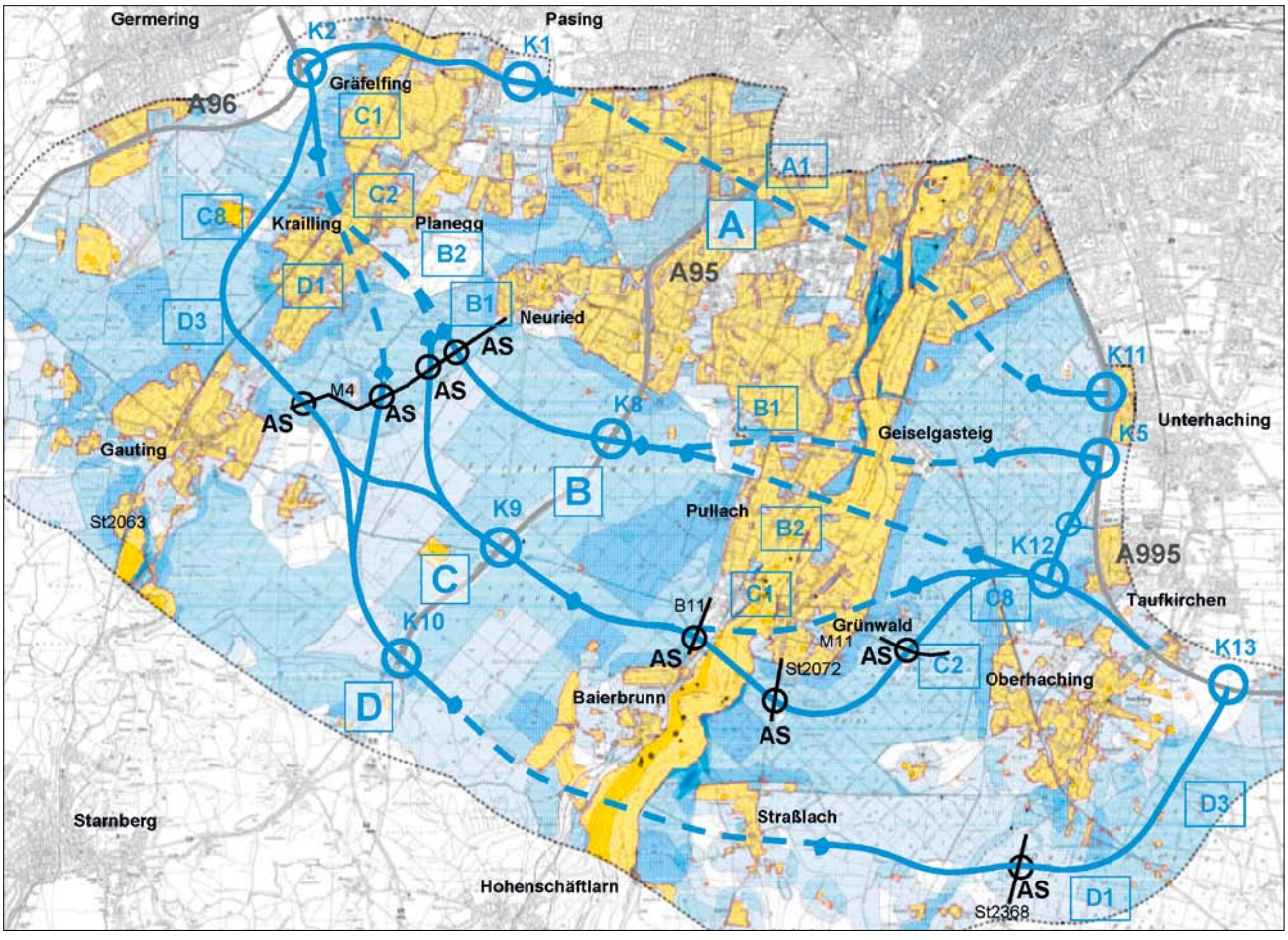


Picture credits: SSF Ingenieure AG

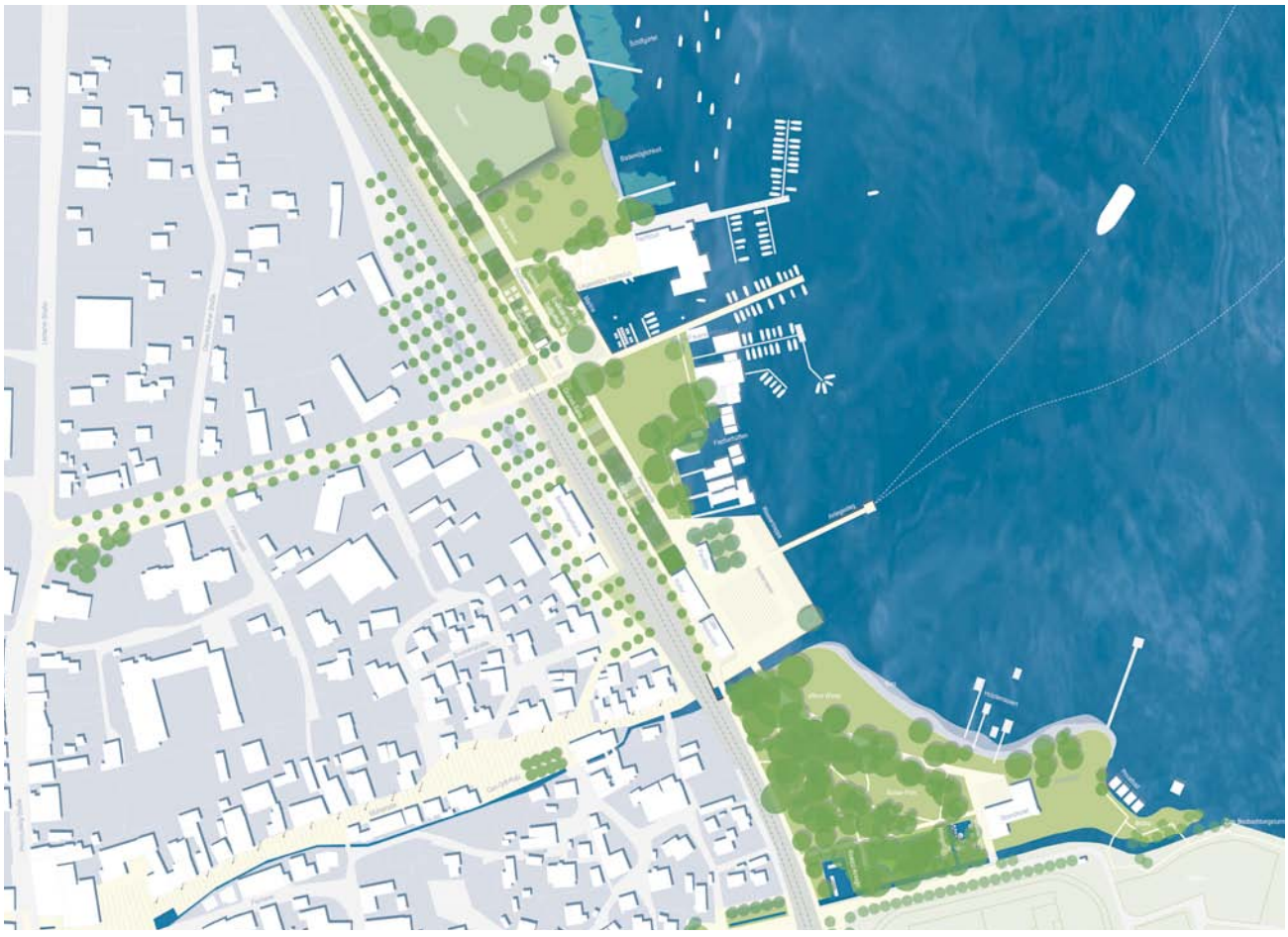
Sustainable Concepts for Cities and Landscapes

This field of work presents us with many aims to strive for. The conservation and improvement of life quality, the creation of future-compliant transport systems, the minimisation of surface and energy use, the adaptation to climate change and the attempt to contain it, the preservation and development of biodiversity, the appreciation of various extraordinary landscapes and the design of our 'everyday landscapes'. These enormous tasks cannot be tackled by experts alone. We understand more and more that only participation and motivation of people (users, residents) early on leads to really sustainable solutions supported by society.

Urban and Suburban Development

In 2007 for the first time more than 50 % of humans lived in cities and this portion will augment to 70 % until 2050. This huge urbanisation tendency presents new challenges for engineers and architects. The urban infrastructure is almost always planned for long-term functioning. Therefore, a foresighted, future-efficient design is required, also taking into account aspects such as demographic changes and cultural specifics. Solutions are to be examined for their impact on the environment and their economic efficiency so that future generations do not have to bear unnecessary charges.

SSF Group has gained experience over many decades in the fields of infrastructure engineering, from infrastructures such as subways, roads, car parks, railway lines to building projects such as railway stations, airports, office and residential buildings, but also in the wide ranging areas of environmental and landscape design.



Picture credit: PSU / Böhm Glaab Sandler Mittertrainer Architekten

We are acquainted with establishing structural concepts for communities and on this basis with the development and support during the elaboration of area development plans, master plans for urban development and implementation processes.

For a high-quality and long-term urban development priority is the conservation and promotion of quality. Also very important are calm areas, green corridors and networks, short distances, cyclist and pedestrian friendliness, micro-mobility and a well-developed public transport system becoming an ever more important alternative to individual car traffic. Green spaces in the city provide recreation in the neighbourhood for habitants and contribute decisively to adapting the cities to climate change by their favourable climatic effect. An important aspect of sustainability, especially in the context of growth of cities, is the minimisation of surface use and the exploit of potential infill development. Especially suburban areas, the often 'faceless' growing city belts, are a cultural challenge for urban planners and landscape architects, engineers and architects.

Development of Rural Areas

The growth of cities is only controllable by strengthening the rural areas and giving them a higher profile – interaction between urban knots and spaces close to nature on regional level is required. In particular the infrastructure in rural areas has to be updated (e.g. telecommunication, accessibility/traffic connections, local supply). To offer a wide range of jobs, the establishment of companies is indispensible; however, intercommunity solutions

New design of lakeside installations in Diessen at lake Ammersee (left): Die vorhandenen The existing green spaces are overused, partially functionless, the urban link to the town centre is poorly developed and the water is only partially experienceable. A clear concept of roads, moderate changes of the existing installations, a café and the enhancement of the road network between residential area and the water create a new quality of experience at the lake.
Project of Prof. Schaller UmweltConsult in cooperation with the office Böhm Glaab Sandler Mittertrainer: competition participation, 2nd prize

Green space plan with integrated environmental impact assessment, Munich-Lochhausen (above): A residential area with around 600 apartments including infrastructure in a 13 ha large design area is planned. The requirements to the design concept are innovative structural and open-space constructions in increased built-up density, preservation of valuable landscape, ecological urban development, connection to the adjoining residential area and reinforcement of the essential function as town centre. An environmental impact assessment has been carried out in consideration of complex groundwater conditions (geohydrology) and prior pollutions (hazardous waste from the past, railway noise, electrosmog, vibrations).
Project of Prof. Schaller UmweltConsult

Land-use plan Regnitz island, Bamberg (below): The area of the ERBA plant – a historic cotton mill in Bamberg – is converted into a residential area with 2-storey town houses. Aim is to conserve the protected buildings, to construct new buildings at an attractive location near the Regnitz canal and to transform the vast fallow land into a natural park (Regional Garden Show 2012). After a detailed analysis and evaluation of the actual natural situation, landscape conservation and architecture principles and goals had been established and the land-use plan with integrated open-space plan and environmental report has been developed.
Project of Prof. Schaller UmweltConsult

should be favoured. More than today, the particular qualities of rural areas have to be appreciated and to be preserved: cultural landscapes, cultural and creative innovation forces, recreational areas and ecosystems such as drinking water, food, climate compensating effects, renewable resources and bio-diversity. Our design services appropriate for a sustainable environmental protection comprise for example landscape development concepts, landscape reference plans, landscape and land use plans, area development plans and open space plans, bio-diversity analyses, conservation and development plans, special protection area plans as well as process support and consulting for different levels of project participation.

Climate Protection and Renewable Energies

Regenerative energy generation by wind, water or photovoltaic power or renewable resources are becoming more and more significant. A particular challenge is to find sustainable solutions which not only satisfy the current energy need but which are integrated appropriately into the landscape too and preserve at the same time biodiversity and resources. In this field of work we have accumulated know-how and are always keeping up with the times. We face more and more – just in the sense of sustainability requirements – tasks beyond individual disciplines and areas. We develop in especially selected teams intercommunity climate protection concepts to be able to actually reach the aims of energy policies.

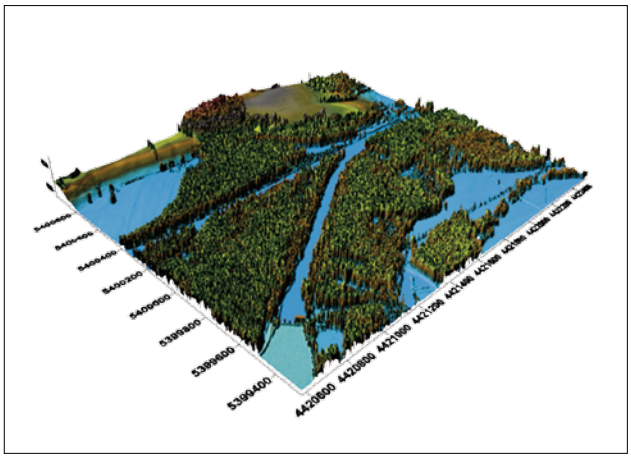
Landscape Planning and Landscape Architecture

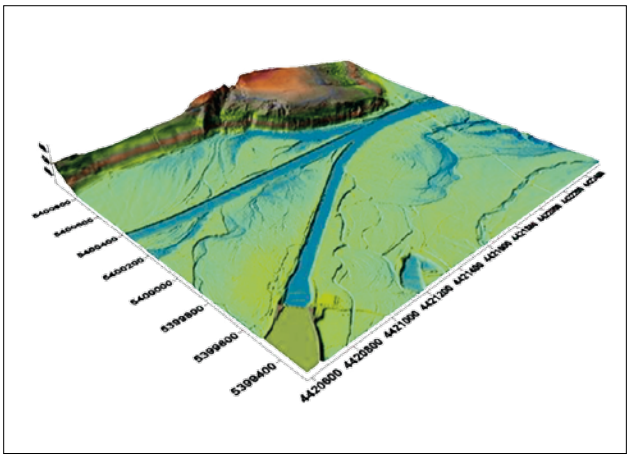
For designs involving constructional interventions, we have been developing over the years landscape and environment planning instruments: environmental impact studies, Natura 2000 compatibility studies and landscape conservation plans. Impacts on the environment caused by constructions are reduced by mitigation and minimisation measures and remaining damages are compensated with suitable measures as much as possible. We understand that each intervention into until now unused area weakens ecosystem functions or brings it to a standstill. We also know that each compensation measure can only partially compensate the intervention's effects but never completely reverse them, especially regarding the protected good soil. In cooperation with Technische Universität Munich we try to find solutions to these problems.

We offer special expertise in the field of water (hydraulic engineering, hydrogeology, limnology). For many years we have been examining the effects of and developed the necessary environmental measures for large-scale water power projects and inland waterway transport. We provide expert skills for any groundwater related subject as well. In addition to sustainable preservation of natural resource, protection of landscapes, biodiversity and biotopes, our landscape architects dedicate their work to the aesthetic and innovative design of structure-related open spaces, parks and green corridors. Our landscapes and cities are not only designed for long-term function, but also for beauty that appeals our senses and increases our quality of life.

Geodesign

Geodesign is the combination of CAD design systems with geotechnics to verifying the environmental impact or the sustainability of design concepts.



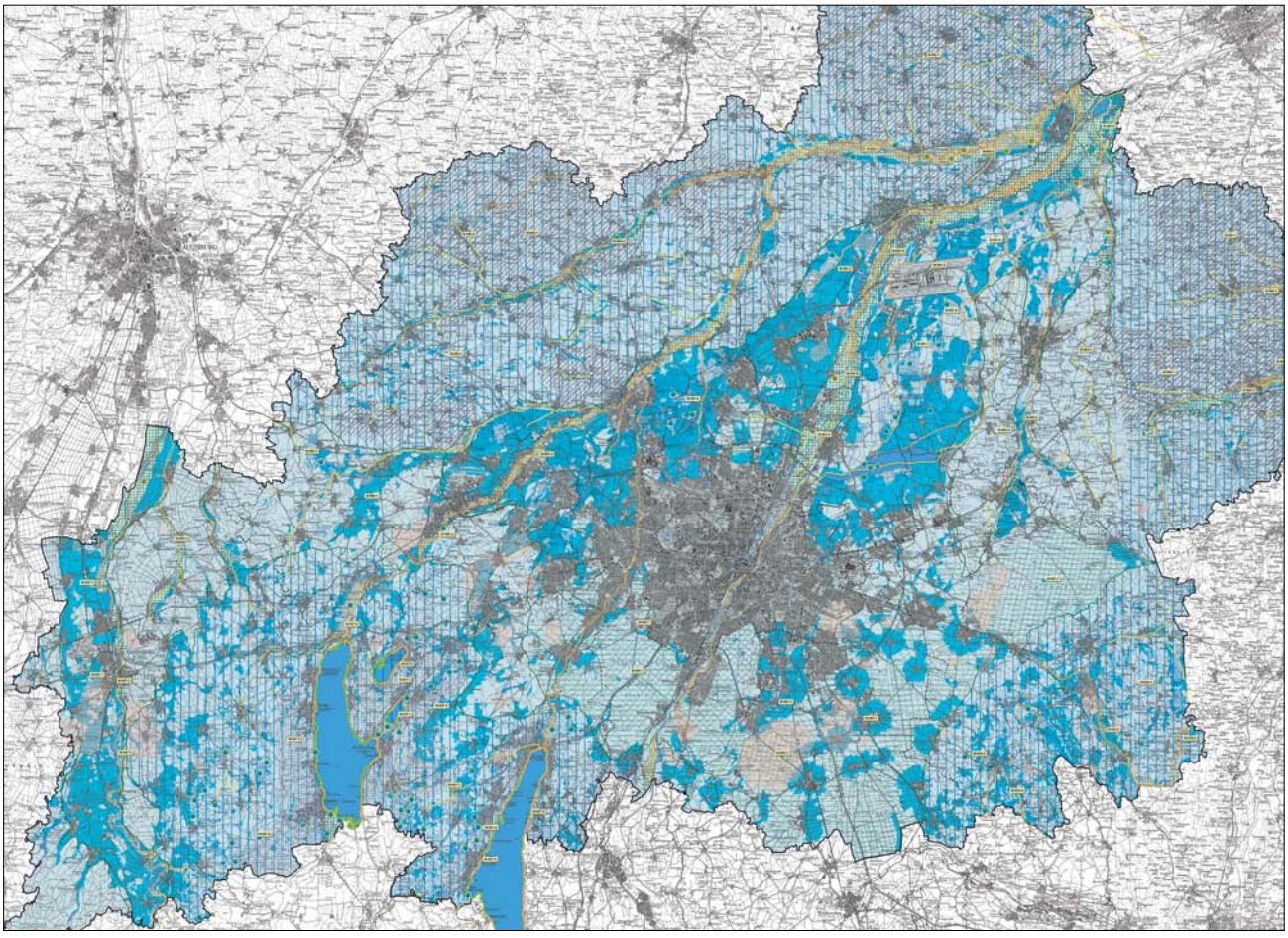


Picture credits: PSU

The existing CAD technology is connected with GIS methods to define with appropriate tools and models the quality of a design, directly in view of its environmental effects. This technique is applied to every area of urban, infrastructure and landscape design to visualise the effects of designs on the environment, to assess them and to optimise them directly during the design process with regard to their sustainability.

Pilot project Danube barrage in Donauwörth – high tide simulation (left): Aim was to generate a digital terrain model for hydraulic model calculations. A multi-stage, GIS-based adaptation and reduction procedure extracted around 100,000 points out of 3.5 million laser data points to obtain a manageable data base, from which a DTM generated contours. When the amount of data is reduced, laser data are more precise than conventionally generated photogrammetric data.
Project of Prof. Schaller UmweltConsult

Regional landscape planning (right): Local planning projects have to take into consideration regional prescriptions such as transport routes, green corridors, vast preserved or preferred areas. Regional planning concerning several communities consists of establishing special concepts of use covering one whole region and of determining preferred or reserved areas for specific uses. Interests of nature and environment and sustainable use of existing resources, e.g. water, have to be included in the overall planning. Therefore, regional landscape development concepts are established as basis for decisions taken in the framework of regional planning.
Project of Prof. Schaller UmweltConsult



Picture credit: PSU / Büro Schober

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