



photo: Erik Berg

OSLO OPERA FOR THE 21ST CENTURY

Words by Sarah Rushton-Read

To plan, design and build a brand new opera house is no mean feat, especially when it will effectively house two producing companies, each of them running their own busy repertoires. For the opera and ballet companies of Den Norske Opera, it has taken almost a century of thinking, 10 years of planning and four years of building to fulfil its dream - to inhabit and work in a state-of-the-art facility, which more than equals the best opera houses of the world.

Oslo Opera House is a magnificent symbolic realisation of a nationally supported public building. The architect was appointed via an international competition and the Norwegian people were invited to view all 350 entries and make their judgement. Over 70,000 Norwegians participated and it was their opinions that played a substantial part in the look and function of the building.

Echoing that same collaboration between a government and its public was the collaboration of the organization itself with its staff and invited consultants. Even before the architect was appointed, UK consultancy Theatre Projects Consultants (TPC) was engaged by the Den Norske Opera development team to bring its theatre design experience to the conception of the opera house.

TPC's role was to assist in formulating a clear understanding of what the Den Norske Opera required from its new home. Alan Russell, project director, TPC explains: "Our first contribution was assisting the opera company in determining the room programme and therefore the brief for the project. We had numerous discussions with each of the company's departments, both on the aesthetic and technical sides of the project, and the management of the space. We had to ascertain the best flow between the two main performance rooms, the back stage building and rehearsal spaces, plus the offices. We also had to establish what each area needed to achieve. All this was conducted over a two-year period and well before the architectural competition was launched."

The result is that the Oslo Opera House, unlike others one could cite, has been architecturally designed around its function, as opposed to its function being squeezed into or constrained by an architectural concept. Its visual impact is monumental: a vast, sloping roof, clad with 35,000 slabs of white marble, the building rises like a giant modernist ski slope, or sculpted ice flow, from the waters of the Oslofjord.

In the early stages, before the architectural design, TPC was primarily concerned with the building's dynamic as a productive and successful place of work. Russell explains: "We distilled the essence of the two years of consultation into a very large book, which became the brief for an open international architectural competition. Around 350 architectural practices entered."

About three weeks before the closing date of the competition, local Oslo architectural practice Snøhetta decided to get involved. By chance, one of the senior partners was someone TPC had worked with in California. TPC took on an intensive three-week consultation period with the company and assisted in fine-tuning its entry. Snøhetta went on to win the competition and so began a very positive relationship between the two practices.

With Snøhetta appointed, Den Norske Opera put out the tender for the technical equipment specification. Theatre Projects won the stage equipment and stage lighting element. The sound and comms went under a wing of the M&E consultant and was eventually carried out by a Swedish group, Benum.

BrekkeStrandArup (BSA) - a joint venture between international auditorium acoustic design company Arup Acoustics and local consultancy Brekke & Strand Akustikk - won the contract to design the acoustic for the main performance venues, with Arup focussing on the opera house and Brekke & Strand the noise control and room acoustics of the smaller theatre.



photo: Trond Isaksen

In the meantime, TPC found itself in the unusual position of being subcontractor to the two primary contractors on the project. Statsbygg - the state's primary advisor in building and property matters and principal property manager and developer - and the architect, Snøhetta. TPC specified stage machinery and lighting for the former and advised on the planning and layout of the building for the latter.

What's perhaps surprising, when you look at the plans of any producing opera house, is the relatively small footprint the auditorium appears to occupy in these immense buildings. In Oslo's case, it's all 38,500sq.m of it. However, when you think about the building's functionality it's clear that to maximize efficiency and allow the creative process to be all the more fluid, it makes perfect sense to encapsulate the whole operation in one building. By default, it also ensures that those who craft the physical infrastructure of a production are closer and more engaged with the process.

Workshops for set-building, prop-making, costume, wigs, armoury etc, are all housed on-site in a part of a building known as the 'factory', very much defined by its own architectural style. Russell elaborates: "Our major challenge was in the complexity and plethora of systems the house had to accommodate. Being a fully producing venue, housing its own carpentry, metal and plastics workshops, wardrobe and wig-



photo: Trond Isaksen

making, armoury and numerous other departments - we needed to incorporate this into the working dynamic of the building. Plus, of course, there are a number of rehearsal rooms, the second studio theatre venue and the number one rehearsal room that doubles as a public space with capacity for production lighting and set. For us, the first stage is to organise all these spaces so that the backstage works logically and efficiently alongside the needs of each production."

To that end, a huge road runs all the way through the factory areas from the load-in at the back of the theatre to arrive at soundproof dock doors at the back of the stage. This allows trucks to unload directly onto the stage. Of course, the road also links the large build workshops and rooms on either side with the performance spaces. Whilst the planning may well look like common sense, it clearly took a great deal of effort and negotiation to get to that point.

More specifically, designing opera auditoria brings with it a diverse combination of demands and considerations - there's the acoustics, which need to accommodate the spoken voice, the sung voice and the orchestra, plus there's the desire of the audience to be as close as possible to the action. To crystallize these demands with the huge backstage facilities, in as harmonious a way as possible, is complex - especially as every part of the operation

presses for its own little piece of perfection. Russell gives an example: "Musicians always want a larger orchestra pit than we can give them. After all, the bigger the orchestra pit the further the audience are away from the stage. It's a delicate balance and there are many other comparable balances that have to be struck."

Inside the opera house the two main performance spaces - the main auditorium seating 1360 and the smaller multi-configurable studio, which seats a maximum of 400, depending on its layout - appear to have been carved from a giant oak tree growing inside this iceberg of a building. A balance between form and function, a tall, beautifully curved, Baltic oak interior wall divides the public and performance spaces. Balcony fronts are

traditional proscenium-type grand opera," BSA worked closely with Snøhetta and TPC to develop the room form and finishes so as to integrate the functional, aesthetic, and acoustic requirements in a homogenous and harmonious manner.

Rob Harris, director of Arup's Performing Arts Sector, explains: "Many old Italian opera houses have short reverberation times - around a second, making the words sound clear but the orchestra dry; modern houses tend to have longer reverberation times, perhaps two seconds, producing a more concert-like orchestral sound. The brief in Oslo followed this trend, so the challenge for BrekkeStrandArup was to provide the right balance between the two. We carried out acoustic analysis of the developing design using room acoustics

provide a less resonant acoustic for contemporary (electronic) opera and for the occasional amplified concert."

Scandinavian distributor Benum supplied a complete TTA Stagetracker 16XR system with audio matrix and dual RadioEye detectors. This allows the control of the perceived direction of the reproduced sound through the speaker system in response to the movement of performers in the physical space. The company also supplied an FX Audio Editor, which provides control and arrangement functions for sound effect playback.

The TTA Stagetracker system is used in both auditoria, with the large stage area of the main hall utilising two RadioEye tracking devices mounted in the truss above the



hand-carved by Norwegian boat-builders: it's a truly amazing environment.

A traditional horseshoe shape, the auditorium balcony fascias and walls are crafted from the same Baltic oak as the foyer, but darkened to increase the sense of intimacy and warmth. Russell says: "The initial design of the auditorium had already been carried out for the competition brief. I would say that we were substantially responsible for the geometry and shape of the auditorium because we needed to establish good sightlines from every seat early on. Acoustically speaking, consultants BSA were given the design at a reasonably advanced stage in that design process."

A comprehensive brief from Statsbygg and TPC called for "excellent acoustics for

software, then fed the results back into the design process. This allowed the designers to listen to the room before it was built.

Over 200 versions of the model were made to investigate the effects of proposals. In addition, we built a 1:50 scale model of the Store Sal room to carry out further tests."

Jeremy Newton, auditorium acoustic designer for Arup, says: "We needed to maximize the volume while still providing intimacy in the relatively small space. The room is narrow low down, which provides clarity and intimacy, and wide at the top, which provides the reverberance required. Because the ideal acoustics of a hall are different for different performances, the house has a large area of curtains installed. These can be extended into the room, using computer-controlled motors, to

stage or around the perimeter of the performance space.

"Sound engineers at the Opera House are excited about the Stagetracker system," reports Benum's Ronald Hernes. "They see it as a piece of technology that will allow them to concentrate on their sound mix rather than audio positioning."

Benum is a significant contractor to the National Opera House project and delivered all pro audio and video equipment including stage manager systems, along with one of the biggest control systems ever built for an opera house comprising a Nexus audio network and Aurus console. The audio system was designed and specified by consultants Artifon AB of Sweden and COWI AS of



From top;

Alan Russell, project director, TPC.

Rob Harris of Arup.

Jeremy Newton of Arup.

Norway, and installed by Benum in conjunction with YIT of Norway. Electro-acoustic evaluation for loudspeaker system design purposes was carried out - using a combination of EASE, EASERA and Norsonic NOR118 - by Renkus-Heinz VP of R&D, Ralph Heinz, Robert Nilsson of DAT, Alf Berntson of Artifon and Benum's Sverre Jøssund.

Benum supplied over 200 SMRT audio distribution outlet boxes, the Renkus-Heinz loudspeaker system, the Stagetec consoles, a ClearCom wireless and wired comms system, and a Medialon-distributed paging system for the orchestra.

Alf Berntson at Artifon was responsible for the main halls and the complex, custom-designed Stage Management system for both main auditoria. Frode Bye at COWI was closely involved in the signal distribution aspects and other aspects.

The main and rehearsal halls feature a sound reinforcement system based around Renkus-Heinz self-powered and externally powered loudspeakers, with Yamaha DME64 digital processors. The system provides a choice of switchable configurations to suit the type of performance, from solo voice through small band and orchestra to a rock band. Signal routing to the main loudspeaker arrays (located in left and right movable loudspeaker "towers") can be configured to effectively create two 'systems within a system' - with the upper loudspeaker cabinets handling vocals and the lower cabinets handling instruments, to maximise separation and clarity. There is also a flown centre cluster to provide an L-C-R sound image across the stage.

The loudspeaker system is specified to handle anything up to and including a full rock concert, and is interfaced with a Yamaha DME64 Digital Mix Engine and in turn to the Stagetec Nexus network via AES/EBU.

It provides four individually selectable modes, electronically configurable via the DME64's 64-way output matrix, allowing instrumental and vocal signals to be routed to different combinations of loudspeakers to suit the type of performance: Mode 1 - 'Song System' - configures the main proscenium system as Left-Centre-Right plus Fill; Mode 2 is the 'Instrument System', configured as Left / Right plus Fill; Mode 3 is designated 'SOR' (Source Oriented Reinforcement) and Mode 4 provides 5.1 surround sound.

Two Renkus-Heinz ST4/4-2T full-range cluster cabinets per side, and a pair of centrally flown ST4/4-2T, form the main L-C-R system, plus one ST4/9 per side as front-fill, augmented by four DR18-2 subwoofers - all self-powered and

controlled over Renkus-Heinz's proprietary R-Control network. The latter also controls a row of four compact PN61 self-powered cabinets along the stage front, which provide front-fills.

"The ST Series cabinets were selected for their very low distortion and colouration," says Benum's Sverre Jøssund, "combined with compact dimensions relative to their maximum output level. The latter was important because of the need for the complete system to be aesthetically unobtrusive, yet be able to deliver very high SPLs when required, for jazz and rock performances, as well as very pure vocals and solo instrumentals."

Under-balcony fills are provided by passive PNx81/9 and PNx61 loudspeakers, driven by QSC CX502/1102 amplifiers, while the surround and delay fill system comprises 52 PNx61 externally-powered compact cabinets, again QSC-driven. Finally, five more PN81/9 cabinets are flown from the lighting bridge for further delays. Microphones are a combination of Shure UR1 pocket transmitters with DPA 4061 and 4088 mics. There is also a selection of Shure UR2 Beta 87C hand-helds with transmitters.

Another dramatic contributing element and perhaps bringing sound and lighting ever closer together is the stunning chandelier suspended inside an oval acoustic reflector. Weighing in at 8.5 tonnes, it is both the auditorium's main source of illumination (via 800 LEDs, which shine through 5,800 glass crystals) and an important acoustic element which scatters and diffuses the sound, contributing to the reverberance of the room.

For stage lighting, TPC was asked to ensure the systems specified were as flexible and future-proof as possible. Over the stage, lighting is hung from a series of five lighting bridges, typical of European opera houses. On either side of stage, however, are two mobile towers, which allow adjustments to the width of the proscenium without damaging the acoustics. The double level, number one bridge can also alter the height of the proscenium.

The overall lighting package was awarded to Norwegian company Elpag AS. Den Norske Opera chose the ETC Congo package for performance space lighting control. Congo Juniors are used as both a "designer's remote" and in the stage manager's booth, linking to the house and work light system, which in turn are controlled by three E.GO Prego systems. These flexible systems interact with the ETC Congo stage lighting control along with the stage manager's system, plus a large number of control panels throughout the venue.

An Ethernet network links the production lighting control to one of the first Strand

photo: Erik Berg



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Sine Wave Dimming installations of this type - specified to eliminate harmonic noise in the auditorium.

Over 300 Selecon Performance Lighting luminaires service the performance spaces. They range from short- to medium-throw Acclaim PCs and Rama High Performance Fresnels and PCs to long-throw Arena High Performance Fresnels and 1000W Lui 4-way cycs and groundrows. There are also numerous 1250W Aurora four-way pole-operated cycs and standard groundrow units. Moving lights are primarily Martin MAC 2000 Performance and MAC 2000 Washes. Numerous PAR 64s, all with scrollers, fill out the overhead rig. In addition, the basic lighting rig comprises HMI wash, tungsten 2kW Fresnels and ETC Source Fours.

Numerous Robert Juliat 1.2kW 600SX zoom profiles and 2kW 700SX zoom profiles, with various lens tubes, are employed front-of-house, overhead and on side-booms, while followspot positions are filled by four 2500W HMI Robert Juliat Cyranos, four short-throw 1200W HMI Lucys and two of the company's 1200W HMI Super Korrigans. Theatre Projects Consultants wrote the final specifications for lighting equipment in consultation with the technicians at the Opera House.

"Our choice of Robert Juliat was not difficult," says head of lighting, Paul Vidar Saevarang, who has worked at the Opera for more than 20 years. "We've always used Robert Juliat. They're solid lanterns, which perform well over long periods. You get a great light out of them and they are excellent for projecting gobos - which we use a lot. "

Equally sophisticated is the stage machinery, as Russell explains: "The general aim is to be able to move a set onto the stage from any direction, with each set being up to a size equal to the stage. There are quite different techniques for the horizontal movements required at stage level to the vertical movements which are possible from above and below. These movements may be required by the demands of a particular production, but are made more onerous by the demands of repertoire working, where the same performance is seldom given on consecutive days and several performances with their attendant rehearsals have to be mounted each week."

To that end, Oslo Opera House has one of the most modern and technologically advanced opera stages in the world. It comprises 16 individual elements, which can be elevated, angled or rotated, opening up the opportunity for set designers and builders to create wonderful and dynamically sophisticated landscapes on stage.

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In addition to the main stage - 16x16 metres - there are two side stages, a rear stage and an understage which facilitates the preparation of scenery sets up to nine metres high under the main stage, and their elevation during performance. Responsible for supplying the complete electrical and hydraulic control plus the drive technology, as well as the steel structure for the stage technology was Rexroth, part of the Bosch Group. As the main contractor, Rexroth was responsible for the project planning, supply and installation of the entire stage technology and specialists from Norway, Germany, Hungary and the Netherlands worked closely with TPC to realize this. In excess of 200 drives have been used for the above-stage machinery, apparently marking a new world record.

Jürgen Konertz, project manager of Rexroth elaborates: "Under the stage, 80 powerful, yet extremely quiet hydraulic drives power four large elevator podiums and 16 secondary ones, plus a diverse array of orchestra and equalisation podiums. The chequered adjustable stage offers directors a high degree of dramaturgical flexibility; every secondary podium can be adjusted individually by four hydraulic cylinder drives, in height and incline. A revolving stage with a diameter of 15 meters and a rotation speed of 1m/s complements this extensive install."

The most satisfying aspect of the Oslo project for Russell is the collaborative way in which every individual, company and organisation involved, has worked. He states proudly: "At the end of the day we really have got the best of all possible worlds. Nothing can ever be 100% perfect; there will always be those things that you look back on and think, 'I might have done them differently.' However, I have to say it's the closest I've ever come to fully realising any brief, for any building so far."

Oslo Opera House belongs to the government of Norway and its citizens; there are no private partnerships here. It is democratic in its realization, both in terms of the selection of its designers, the way they then worked together and ultimately in Den Norske Opera's utilisation of the building.

Norway's Parliamentary Bill number 48 (2001-2002) states: "The building shall stand as a representative institution presenting both Norway's cultural traditions and the Norwegian National Opera's significance in the Nation's culture and society." This it has truly achieved.

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