How did your academic background lead you to specialise in the holistic usage of natural resources, and what motivates you in your work?

My career began as a forester. I then decided to study forest products technology and timber construction, and following this, mathematics in Salzburg. For my PhD, I studied at the University of Agricultural Sciences in Vienna and the Technical University of Graz, where I finished my research on the simulation of production processes in forest products industries. Importantly, I gained insight into different scientific disciplines on the topic of materials and production processes. Thanks to these experiences, I realised that the real potential of development in the ‘old-fashioned’ forest products technology field lies in holistic developments rather than partial solutions.

To what extent is intelligent resource utilisation important for addressing resource shortages in the future?

With our use of available resources continually increasing, it seems more likely that we are going to experience resource shortages in the near future. In my opinion, survival of the fittest will become the survival of the most intelligent rather than the victory of the strongest. We must therefore increase the intelligence behind our actions.

If we look at the usage of trees, for example, the current focus is on the production of sawn timber, which is less than 50 per cent of the total resource; indeed, in the conversion chain of roundwood to timber, the yields of the production processes are less than 65 per cent. If we can reduce the dissipation of resources in our modern product development and production processes, this could lead to the avoidance of resource shortages.

What are the benefits of using wood materials to address resource shortages?

From our perspective, benefits can be derived from using all resources associated with trees, including wood, bark, leaves, needles and seeds, among others. The greater use of these materials will increase the amount of resource output without increasing the quantity of felled trees. As wood is a renewable material, in the long term, no shortages will occur if the principles of sustainable management are upheld and respected.

Biomaterials research surely calls on a number of disciplines; how do you approach such a multifaceted field?

In our team, breadth of knowledge is essential to solving our multidisciplinary research questions. Depending on the research question, technologists must be supported by mathematicians, chemists, biologists, economists and other scientists.

How important is collaboration with other universities?

The development of new products and processes in the supply chain, from the forest to the end consumer, involves knowledge from different fields and, therefore, collaboration with other universities all over the world is essential. We have strong scientific and student exchange links with universities in Europe, North and South America, Africa and Asia. Our partner institutions do not only support us with specific expertise in their focus fields, but they also provide laboratory equipment, allowing us to make use of machines we could never afford in Salzburg.

Seeing the wood for the trees

Professor Alexander Petutschnigg and colleagues are working to optimise efficiency at every stage of the wood supply chain, developing inspired methods of engineering and biomaterials science to make each log go a little further.

FINDING FINGERPRINTS
To combat the illegal felling of trees, Petutschnigg and his team are devising a database of ‘fingerprints’ for trees by obtaining crosscut images of logs from forests across the world. This enables the optimisation of the whole supply chain and the secure identification of illegally felled trees.

DRIVING DURABILITY
The team at Kuchl are impregnating wood with bark extractives to prevent quick biodegradation. Not only does this technique increase the durability of exterior applications of wood and enhance fire resistance, but its ability to change the colour and odour of wood means that it can also be used in the creation of aesthetic products.
Transforming waste from wood

An interdisciplinary team of researchers at Salzburg University of Applied Sciences, Austria, is finding new uses for one of humanity’s oldest resources – and their work is contributing to a more sustainable future for all.

THE IMPORTANCE OF wood cannot be overemphasised. Historically, it served as humanity’s primary source of heating fuel and building material – and it is still used today as a major material in houses, furniture, decorative artefacts and pulp-based products, including paper. Yet, the continuing demand for wood materials coincides with diminishing resources and a burgeoning global population.

Professor Alexander Petutschnigg and his colleagues at Kuchl campus of Salzburg University of Applied Sciences (SUAS), Austria, propose a two-pronged approach to transforming the wood supply chain. With the ultimate goal of minimising wastage at every stage, from felling to final product, Petutschnigg’s research is inherently multidisciplinary. Together with his team and collaborators, he is pioneering a holistic approach to the usage of wood resources by promoting higher efficiency in existing processes and the upcycling of residues.

OPTIMISING EFFICIENCY

Wood may be the principal tree-derived material, but it is certainly not the only one. Trees also produce so-called ‘extractives’, solutions that protect the tree from bacteria, fungi and insects. The antimicrobial and insecticidal tannins that confer these properties are of potential benefit to humans; however, when wood is dried prior to being used as a building material, these extractives evaporate into the atmosphere.

In response, Petutschnigg’s group suggests the use of a purpose-built vacuum chamber to isolate these extractives by steam distillation, the process through which perfumes and other organic compounds are isolated. The group’s latest publication details the antimicrobial efficacy of larch- and pine-derived extractives, which effectively inhibited the growth of gram-positive bacteria such as Staphylococcus aureus.

Additionally, due to increases in both material costs and production processes in the construction industry, the Kuchl researchers are simulating and developing new joints and constructions based on the framework of the human skeleton. “These constructions are optimised for dynamic loads and the results are implemented in a range of applications, such as new ski cores for ultra-light skis,” Petutschnigg outlines.

UPCYCLING RESIDUALS

As the process of re-purposing or transforming by-products or waste materials into objects of superior value, upcycling has become extremely popular in recent years – and Petutschnigg and his team are applying this procedure to the transformation of wood residues.

For instance, the researchers are using tannins, as an extractive of bark processing, to produce natural foams – that is, renewable insulation materials that could replace synthetic foams such as polystyrene. In addition to being effective thermal insulators, tannin foams are also fire-resistant, unlike the highly flammable polystyrene.

Moreover, the team also demonstrates that residual bark – produced during the conversion of roundwood from trees to timber boards – can be used as a construction material. Its low thermal conductivity and high specific heat capacity make it an excellent heat buffer; indeed, a building insulated with bark experiences minimal heat loss.

Petutschnigg’s upcycling endeavours also include the development of a new material based on a combination of wood residuals and leather waste from homogenisation processes. Interestingly, the two component parts of this innovative material compensate for the physical limitations of the other. For instance, the leather waste endows the composite with fire resistance, while the wood residuals provide mechanical stability and prevent the leather from melting. The resultant material is therefore durable, renewable and safe.

Ultimately, the R&D innovations in the Kuchl lab are testaments to the power of interdisciplinary collaboration. Continuing with their holistic approach, Petutschnigg and his team are planning to seek sustainable solutions to global problems, focusing on improving efficiency and upcycling residues.