The Cambridge Forum for Sustainability and the Environment

Meeting 7: 28th April in Downing College

Aims

This year, we are focusing on challenges related to the way we use land and the supply and demand for natural resources in the future and to think about the research pathways that will help us to prepare for and address the challenges we will face in the future.

This month, we are 'looking into the future' of a specific resource - wood - and we'll use it to make links between innovation and design, and the future supply and demand for natural materials.

The panel of witnesses will explore how shifts in the way we use wood may change and by focusing on timber in buildings, we are hoping to generate questions related to both forestry production and the kinds of materials that architects, designers and engineers will looking for in the future.

Agenda

All the witnesses will give a 10 minute introduction and their perspective on the two core questions followed a general discussion:

5:00pm	Welcome by the Chair and an introduction to the topic
	Each witness gives a short introduction and thoughts about the questions (10 mins)
	Questions and beginning the open discussion
6:00pm	Coffee break
	Continue the discussion in three groups and then come together for final thoughts
7:15pm	Reception and dinner, which will include a working session

Witnesses

This month, the three witnesses are:

Professor Peter Freer-Smith	Chief Scientist, Forest Research and Forestry Commission
Jon Kirkpatrick	Head of Sustainability, Europe, Lend Lease
Michael Ramage	Senior University Lecturer, Department of Architecture, University of Cambridge

Questions

The witnesses have all been asked two core questions:

1) What do you perceive as being the main gaps in our knowledge?
2) What would you include in the 'next generation' of research questions?

Each of these questions will be posed to everyone and their answers will then be used as a springboard for further discussion. The main points raised will then sent to everyone to use as a starting point for the next meeting.

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Witness profiles

Professor Peter Freer-Smith

Chief Scientist, Forest Research and Forestry Commission

As Chief Scientist for Forest Research and Forestry Commission, Peter ensures that Forest Research provides the scientific knowledge and expertise required to achieve sustainable forest management. He ensures that advice to policy makers and practitioners is based on good scientific understanding and sound research and contributes to the formulation and implementation of the Forestry Commission's policies and objectives. Additional responsibilities include Head of Station at Alice Holt Forest near Farnham in Surrey (where he is based) and representing Forest Research on the Forestry Commission Research Management Board.

Peter studied for his first degree at Stirling University gaining a first class degree in Biological Sciences. His PhD was on the Impacts of Air Pollutants on Trees. Both his PhD and DSc are awarded by the University of Lancaster. Peter did two periods of post-doctoral research at Lancaster before moving to a lecturer's post at the University of Ulster. He joined the Forestry Commission in 1987. In June 2005 Peter was appointed Honorary Visiting Professor in the School of Biological Sciences, University of Southampton. He was appointed Forestry Commission Chief Scientist in 2009.

Jon Kirkpatrick

Head of Sustainability, Europe, Lend Lease

Jon Kirkpatrick heads up sustainability for Lend Lease across the EMEA region, and acts as the central liaison for all sustainability issues across all of its business units. His role covers two essential areas, environmental operations plus associated performance and development innovation and strategy (both environmental and community investment).

In addition to embedding sustainability across the business, he is also ultimately responsible for sustainability on major projects at Lend Lease, and works primarily on significant urban regeneration projects across Europe (such as Elephant and Castle & The International Quarter). Jon works closely with the development teams to focus on comprehensive urban and infrastructure problems, including finding solutions for renewable energy, water, waste, transport, biodiversity, green infrastructure and public realm issues through integration of sustainability into design. Before joining Lend Lease, Jon has experience across a wide number of major projects globally including the London 2012 Olympic Park and Education City in Qatar as an associate director of EDAW/AECOM.

Michael Ramage

Senior University Lecturer, Department of Architecture, University of Cambridge

Michael Ramage is an architectural engineer and Senior Lecturer in the Cambridge University Department of Architecture, a fellow of Sidney Sussex College, and a founding partner of Light Earth Designs. He studied architecture at the Massachusetts Institute of Technology, and worked for Conzett Bronzini Gartmann in Switzerland prior to teaching at Cambridge.

His current research is focused on developing low-energy structural materials and systems in masonry, better housing in the developing world and improved engineered timber and bamboo through natural material innovation. He teaches, researches and designs buildings, and receives research funding from the Leverhulme Trust, the Engineering and Physical Sciences Research Council, the Royal Society, the British Academy, Cambridge University and industry.

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Meeting details

Duration: **1:54:10**

People who came to it

Peter Freer-Smith (PF-S)
Jon Kirkpatrick (JK)
Martin Ramage (MR)
Adrian Campbell (AC)
Bea Schlarb-Ridley (BS-R)
Bhavna Sharma (BS)
David Coomes (DC)
Dimitra Dantsiou (DD)
Doug Crawford-Brown (DC-B)
Gemma Cranston (GC)
Henry Burridge (HB)
Ian Hodge (IH)
Miles Parker (MP)
Paul Dupree (DP)
Paul Linden (PL)
Peter Guthrie (PG)
Richard Brooke (RB)
Rosamunde Almond (RA)
Simon Smith (SS)
Will Simonson (WS)

Transcript

PL:	So good afternoon everyone and welcome to this April of the forum. First of all we have some apologies: one from Martin Rees who is the Chair of this forum, Martin is at the Pontifical Academy of Sciences in the Vatican which I think is an opportunity for the Pope to speak to God, so we wish him well. Bhaskar Vira can't be here today either, but otherwise we have a good turnout from the forum and some guests. I will in a minute go around the table and ask everyone just to introduce themselves and say a sentence about who they are.
	Before I do that I will just say that the way we operate this is that we have our three witnesses and it's a special pleasure for me to welcome Peter Freer-Smith and Jon Kirkpatrick and Michael Ramage who have agreed to come along and talk to us today. A very special welcome for the three of you and thank you for agreeing to do that and after our roundtable introductions we will hear from them each and then we will have some discussion and a break for coffee and then some further discussion and some people have agreed very kindly to actually give responses to the thoughts from the witnesses as well, so we'll mingle that in with the discussion. Eventually we'll go for dinner about 7:15pm.
	This is very informal so people are allowed to speak whenever they want and we use Chatham House rules so you can say what you like. We are recording it though but we promise never to divulge the secrets of this to anybody other than Google so that should be fine!
	Anyway so I'll start with the introduction, I'm Paul Linden, as I've said I'm in the Department of Applied Mathematics and Theoretical Physics and my interests are in sustainable buildings and the urban environment and environmental globe problems.
PG:	Good evening, I'm Peter Guthrie. I'm from the Centre for Sustainable Development in the Department of Engineering. I'm a civil engineer and my interests are in sustainability decision-making, energy efficiency and overseas development issues.
BS:	I'm Bhavna Sharma. I'm a senior research associate in the Centre for Natural Material Innovation in the Department of Architecture and I primarily look at natural materials for structural applications.
AC:	Afternoon. My name is Adrian Campbell, I'm a structural engineer for Arup in London. I have a background in sustainability and looking at materials I'm now focusing on timber as a major structural material and its opportunities on projects.
HB:	Hi, I'm Henry Burridge, working in the Applied Maths Department with Paul and I'm interested in the role of convection and its application to low-energy ventilation of

	buildings.
IH:	Hi, I'm Ian Hodge, I'm from the Department of Land Economy and I'm a rural economist with an interest in environment, land, property, countryside governance, all sorts of issues.
GC:	Hi, I'm Gemma Cranston, I work for the Cambridge Institute for Sustainability Leadership specifically in the Natural Capital Leaders' Platform, so my particular interest is in looking at food resource, availability of natural resources and supply and demand around that.
MP:	Miles Parker. Once upon a time the Deputy Chief Scientific Adviser in DEFRA and now working for the Centre for Science and Policy here in Cambridge.
PF-S:	Peter Freer-Smith. I was just going to add as well my main professional responsibility is to the Forestry Commission and my visiting professorship is at Southampton University and I work particularly with a group that are interested in biomass energy and hybrid breeding, tree breeding.
JK:	Dr Jon Kirkpatrick. I head up sustainability for Lend Lease for our European operations for a developer and construction company, property infrastructure, a wide range of things and trying to manage all of that and actually engage sustainability across the entire property portfolio we have.
MR:	Michael Ramage, I teach structural design in the Architecture Department and I lead the Centre for Natural Material Innovation and come at this both as a researcher and as an architect and engineer.
RB:	I'm Richard Brooke, I'm the planning and environment manager for the Forestry Commission in the East of England based locally at Thetford Forest and my role in there is to plan the production of timber from Thetford Forest and the replacement species that go there.
PD:	I'm Paul Dupree, I'm a biochemist, a plant biochemist here in Cambridge. I work on plant growth and therefore how wood is formed by the plant and how the different components are assembled together to give the structural properties of the wood.
SS:	My name is Simon Smith, I'm a structural engineer at Smith and Wallwork and I'm also an affiliated lecturer at the Architecture Department in Engineering. I've got quite a bit of experience in timber engineering, I would love to just do timber engineering but unfortunately that's only about half my time, I have to work with other materials which produce a lot of carbon and use a lot of energy, but that's me.
WS:	My name is Will Simonson and I'm in the Department of Plant Sciences where I coordinate the Global Food Security Strategic Initiative.
DC:	I'm David Coomes also from the Department of Plant Sciences and I head a group working on forest ecology and conservation and for the last five years or so we've been working particularly on airborne remote sensing technologies for mapping forests and the changes in forests over large spatial areas.
DD:	My name is Dimitra Dantsiou. I'm an architect and I'm a third year PhD student in the Department of Architecture. I'm interested in low carbon buildings and energy efficiency in the built environment and I'm working on behavioural change as an efficiency tool in workplaces.
DC-B:	I'm Doug Crawford-Brown, I'm a physicist in the Department of Land Economy and Cambridge Centre for Climate Change Mitigation Research where we look at the intersection of energy, economic and environmental, primarily climate policy.
RA:	Hi, I'm Roz Almond, I've got a background in conservation biology but with the forum I'm sitting in Maths with Paul.

PL:	Thank you everybody and it's good to have you all here. So today we are looking at specific resource wood and we have three…many experts around the room about wood actually, I think we are outnumbered by experts this time which is a good place to be.
	So we'll start off first of all hearing from Peter Freer-Smith I believe, that's the agreed order I think.
PF-S:	Yes thank you. It's fortuitous because I think that we progress from supply to utilisation which is probably the logical order. It seems logical to me.
	I wanted to talk about three things we supply globally which is the paper I put round before the meeting and then I'll say a little bit more specifically about the UK and finally I will try and do the more difficult thing which Roz suggested we should try and do and talk about the next generation of research challenges. Perhaps I should apologise in advance that that last bit will be very general and I hope that we can get down to some of the detail later in the course of the evening. I guess it's inevitable that the words we say will be rather general at this stage.
	So the paper I pushed round - I was glad to hear you say Chatham House rules because it's not been accepted for publication and I was a bit worried about that. But actually the FRA's Global Forest Resources Assessment will be launched in the September meeting of the World Forestry Congress which is occurring in September this year in South Africa, so it will be out quite soon.
	So we are very fortunate to have the FRA's Global Forest Resources Assessment, it was only when that started in about 1980 that we started to know what was happening globally. It's very important data. I mean we know that there was loss of forestry starting actually with the Iron Age and continuing, accentuating, accelerating through the industrial revolution and actually still continuing today so having some good numbers for that is important. I mean as you all know around the table that loss of forest cover globally has major consequences for say the atmosphere, it contributes significantly to the rise in carbon dioxide concentration of the atmosphere and obviously major impact on conservation, biodiversity, ecosystem services locally, so it's an important issue.
	The paper explains the latest position which is that forest cover has decreased globally to 3.99 billion hectares and the rate of decrease per year, actually not in that paper but they are…if you look back over the last 20 years annual rates of loss of forest cover are 8 million hectares per year, 5 million hectares per year, 6 million hectares per year, 8 million hectares per year and that's an area about the size of Scotland which is 7.8 million hectares. So it is a substantial ongoing change.
	Then a word about the international politics around that. It's quite important that there isn't a global forestry convention. Of course the Framework Convention on Climate Change and Biodiversity Convention, all sorts of other societies, for example international conventions, do have major impacts on forestry but there isn't a tight international convention or indeed a legally binding European policy on forests. So that's interesting, there is some socio-economic issues around that.
	There are concerns globally of course over illegal logging, timber trade, forest law enforcement and there is a growing global forest certification scheme which is important. So I just mention those things.
	Going back to the loss of forest cover, the net loss that I've quoted is obviously the consequence of deforestation, ongoing deforestation and still actually significantly of natural and primary forests set against woodland creation. So that's important. Plantation forestry is largely the consequence of woodland creation and I wanted to say a word about plantation forestry specifically. At the moment the paper I pushed around shows that plantation forestry globally is only about 7% of global forest cover, really small figure, and yet it supplies 45% of global roundwood supplies. So 7% is supplying

	45% of the needs.
	So that's a really important message. Of course plantations can be very unpopular and managing plantations sustainably is important, but that statistic does suggest that there is actually potentially not a bad position on global timber supply into the future. Provided we manage forests sustainably and we manage our plantation forests effectively they may be able to take the pressure off deforestation of primary and natural forests which is something we would like to achieve.
	So for example the International Union of Forest Research Organisations has a new task force on plantation forestry which will be picking out that issue for the reasons I've just said. That's a new initiative and I'm the UK contact for that.
	So resource intensification is part of the story then for plantation forestry and it's worth just mentioning in passing that plant breeding, obviously hugely important in agriculture, has not achieved the same gains in forestry, only in a very selective way. For eucalyptus though we know the potential is there because for a species like eucalyptus breeding has actually doubled production rates and even in the UK for Sitka spruce our breeding program has increased yield by 23%. Not the sort of increase that you've seen agriculture but significant nevertheless.
	Briefly then the UK situation, that's the second area I wanted to say a quick word about, of course as in industrialisation we actually led the world in deforestation and we managed to get our forest cover down to about 4% at the end of the Second World War. There's a lot of interesting stories around that which I won't go into. Since then we've actually become a centre of excellence in woodland creation and our forest cover has gone on back up to 12%, so threefold increase. That's an extraordinary achievement actually and it's interesting that it's a combination of a state initiative and incentivising the private sector, so there's some interesting things around that.
	Where does it stand now? So UK forest cover is still very low compared with international norms. In Europe the average is around 30%. That increase we've achieved is actually largely a softwood timber supply as I'm sure you know. It achieves somewhere between 8 and 12 million cubic metres of softwood a year, that is only about 40% of the UK utilisation and actually if you go back 20 years it was round about 4%. So a processing industry that was…which you don't have to go back very far to find an industry that was on its knees actually, very near to being eradicated, has come back in and now there is quite a diverse, quite an effective processing industry in the UK including with some multi-international investment.
	The story is very different for broadleaves, for hardwoods as I'm sure you all know, production there is much less, it's about 0.5 million cubic metres, somewhere between 0.5 and 1 million cubic metres and potentially it's much higher than that. The NFU tell us that the potential is about 5 million and we are achieving 0.5. So as Richard will confirm actually Forestry Commission England has had a major drive to try and bring woodlands into management in recent years and that is particularly to try and push up that figure.
	Lastly, the difficult task of saying something about research needs. So I suppose partly as a result of the history that I've glossed over there was a major research effort post Second World War on woodland creation and that was followed by a particular focus on biodiversity in woodlands and we've really moved on from that in recent years. The focus now is much more on resilient forests and that's really two things: in the last 10 years there has been the significant problem of pests and pathogens, plant pests and pathogens, actually also pest and pathogen in agriculture including animal health. But particularly we've certainly had that problem in forests and so there's been a major research effort there and a rather successful research effort. Nevertheless that's something we can talk about.
	The other side of it is climate change resilience and that's brought with it a desire to

	change our species mixture in British forestry and with a change in species there is a need to change silviculture, a need to re-examine utilisation, timber quality coming from new species and quite a significant research focus on those issues.
	I shouldn't finish without mentioning natural capital and ecosystem services so there's been a move…and actually this has consequences for wood supply and wood utilisation, to see the value of woodlands not only in terms of the resource, the provisioning service that they are able to provide, but also in terms of their conservation, their landscape, recreational value, their forest protection, their soil protection, their water management qualities, even flood defence. So that will be important and it is important but it may carry with it a loss of production.
	So I think that's enough from me and there's a whole mixture of things there from some real ecology and biology to some important social, economic and utilisation issues.
PL:	Thank you very much. I think we'll move straight on to Jon.
JK:	Excellent. Apologies I didn't have time to actually send out a paper in advance or a presentation but if I did fundamentally it would go through three main topics, fundamentally around us as a company and what we stand for and actually within the industry why timber would be so important.
	Really focusing on what it means to us actually dealing with some of the pressures in the world but also just picking up on some of Peter's points around some of the social impacts around that at the other end, things that often get forgotten about from a developer perspective.
	So I'm going to try and talk to you a little bit from a developer/client type side which will then neatly segue perfectly into Michael's conversation around actual design side and actually how that factors in.
	From a construction, development and property company perspective I think we are very keen that we understand and recognise that we actually live in a world that has got significant pressures and significant drivers. For us we are seeing it all the time, working from a global context we can actually see that since 2010 we've passed a sort of invisible barrier and we are now over 50% of the world's population are now living in cities, so urban regeneration is a key part of that for us.
	It's a truly frightening thing when you think of actually of all the cities around the world they actually make up about 2% of the world's landmass, so half the world's population are currently standing or sitting on 2% of the planet and as that grows working towards 70% or beyond in 2050, those cities are only going to grow to about 5%, so those pressures are only going to get bigger and much, much bigger.
	As those cities don't grow however I think those footprints dramatically will and when we start to look at land supply and services and even from an ecosystem services perspective all the way down to physical services in terms of the products, that's going to be absolutely massive in terms of those impacts.
	So for us that's obviously been a key driver as a developer working very much in the urban regeneration space and recognising that's where most of the work will be is actually we have the unique position, we are in a scenario where we could not actually only shape cities and work around the actual buildings that we build, but actually recognise those have knock-on impacts across the globe. So for us it's about accountability, it's recognising that if we're building a building for 100 years what actually are the impacts for that. Now for a lot of people that finishes with the building, build a building and you walk away. For us actually it goes a lot further than that. The industry itself has a strong driver on health and safety for example and we actually have an element called Incident Injury Free where everyone has the right to come to work and actually go home safe.

	I've extended that over the last couple of years to recognise that that actually applies to our supply chain as well and actually in terms of ethical trading and understanding what that means has quite a serious impact to our supply chain.
	I have a fantastic slide which I attempted to show our CEO of a man in a forest chopping down a massive ancient tree with no hardhat and no shoes and actually small children pulling things away and I said "Look, actually we have an impact here, that's our boundary, that's how far our reach goes", and immediately he was like "I understand that."
	Now I've got a driver to do that because I also sit on the board for FSC in the UK and actually have a strong opinion but I think actually we should be looking after our forests and I think it's pretty rare for developers to even go that far back in thinking about where our timber is coming from, but actually that's just as important as what we're building to where we are actually taking that from. We are only as strong as our supply chain so that's actually a strong driver for us. As a result that's left us to build significant projects going forward in timber, that's definitely something we're moving towards and trying to move away from concrete and steel.
	We will still build it where it's appropriate but we'll always start to think 'Well maybe we could build it out of timber first? Is it feasible to build that building?' This is where a lot of the sort of research questions come in is because we as a developer often don't know. We are reliant on our consultants and architects to tell us whether it's even feasible or not. At the moment it feels like we're spending a lot of our time educating the people that are supposed to be teaching us what we actually don't know. So one of the big questions I've got really is how do we instil that in a workforce that actually creates that demand so that we can actually engage that and bring that in. We know there are fantastic sustainability benefits of using timber, we know it works fantastically on a construction perspective. CLT building for example, cross laminated timber and we've been really pushing those over the last few years. We built the largest one in Melbourne, tallest storey, I think 11 storeys in a residential block, we just decided to go for it and use it as a bit of research development opportunity and we learnt massive amounts out of that. But it does raise questions. We've got into the scenario where we actually asked the University to do some carbon work for us on that and actually found that the carbon footprint for that building in Melbourne, even though the timber had come from Austria, was lower than using concrete. That staggers me really. Why can't we use local timber? Why can't we use timber from a closer position? The question that came back to me was "Well we don't know what timber is out there, we don't know where the resources are and also it just makes sense to come from Europe because it's well-established." So is that true? Is that real? Is there actually no other industry around the world in terms of timber? All these sorts of questions are going through my mind.
	But there are drawbacks. We have big issues around the use of timber. For us on a construction developer side we have impacts…and I won't go too far because I know I'll be picking some of this up, but around perception of the timber. We have found particularly in the construction side where we're building out of timber it's perceived by the market as a lower grade or it's utilised by lower ends of society. You know we demand steel and concrete because it's strong and because it actually gives us a better building, none of which is true I don't believe. Or is it? Michael may well me differently in a moment.
	There's perceptions around fire, there's perceptions around insurance, around mortgage. All these things have questions attached to them that we can't answer but we really do need to solve that social implication of actually how do we build buildings that people find acceptable and are willing to move into, so there is that driver.
	But from a social aspect we feel actually it moves not only in terms of design but all the way through to operation as well, particularly around the use of natural materials and

	that's probably a debate as to what a natural material is. However, we are strong proponents of things like low VOCs in buildings, natural materials, timber inside interiors, all these kinds of drivers which we believe that actually affects health and well-being in people utilising it and we have an accountability as developers and designers to actually be working on a project which will be in use for 20, 30, hopefully 100 years plus if we get the design right. So how can we impact those occupants? How can we utilise material choices today to actually give them a better workspace or a better home to live in going forward? For us there's just not enough research out there in terms of those impacts, be it physically in terms of being surrounded by timber, what does that do for you, to health and well-being around air-quality and the actual impacts from that. There seems to be and I'm hoping this room will suddenly sprout in to comment in a minute and tell me where I can actually find lots more information. There seems to be anecdotal evidence around schools where we've used timber in the past where children learn faster, where behaviour is better, where heart rates are lower and all sorts of anecdotal evidence that suggests that might be true. I don't know, it would be lovely to find out. But for me it just seems to make good sense to utilise natural materials going forward in those sorts of interior spaces and feeding it into the operational phase.
	However we often come across cost pressures and recognising what's the value, so that cost-benefit psychoanalysis is really important to us as a developer and the more weight behind it in terms of science and people standing up and recognising there is value to that would be really helpful and I think those are probably significant gaps in our minds right now.
	I'm going to leave it there for fear of rambling on for hours, but I'm sure I'll ask more questions later on. I'll let you carry on.
PL:	
MR:	
MR:	But I think in terms of keeping things natural we tend to use some sort of metric where if the thing you end up with is recognisably still plant or timber based it's probably more or less still a natural material and we can talk about what implications that might have. So I mean we find this association with the original form of wood quite important and I think we can probably all relate to that. A tendency to like things that are made of wood, it's even copied in Formica and other non-natural materials quite commonly, so there's something about wood and I'd go with what Jon said, we can't quite put our fingers on it but we like it.
	We're trying to work with tall buildings in natural materials and I think probably that raises a couple of questions: what do we mean by tall and why tall? So for wood we're looking at 10 storeys and above and the important benchmark there is probably the first steel framed skyscraper in Chicago which was 10 storeys tall. So we can legitimately say we're doing skyscrapers if we're 10 storeys or more. I think why tall timber buildings is an important point. Jon's touched on the population of cities and the intensification of cities, I also think that there is an important thing to recognise in doing iconic buildings or iconic research is I think - and we can debate this - but I think there's more to be gained by making a statement for a building that is 40, 50 storeys in timber, demonstrating that it's possible even though we know that 90% of buildings are still going to be 10 storeys or less. Industry and people, the population, the public at large will take notice of a 40 storey building, they won't notice 90% of the 10 storey buildings. So that's one of the reasons we're focusing on tall buildings and probably it's worth saying why timber? It is a natural material, one of the questions that we're actively trying to understand is how sustainable is it? And I think we're coming to the realisation that not everything to do with timber or bamboo or any plant is sustainable and that's something important to recognise, it's also something to be quite sceptical of in sustainability claims, just because it's made of a natural material doesn't mean it's a good idea. But by ignoring

	timber as a major construction material we are basically limiting ourselves to three of the four possibilities, brick, steel and concrete are good but timber is also very good and most iconic buildings around the world actually have very significant timber components. All of our cathedrals have timber roofs, most ancient buildings are timber and some of them are extremely large, so there is a long history of using timber at a large-scale that I think we need to remember and need to reinvigorate. So our aim really is to understand and effectively use the variation in natural materials and we think that the variability is probably much higher in natural materials than the variability in refined materials and that's generally probably seen as a barrier and we're trying to turn it into an opportunity and do things with timber through modification, chemical or biochemical or biological. Because even though when we look at all these wonderful historical examples of timber buildings we don't see the continued use in contemporary buildings except in a very few current special examples. So we want to get to the point where instead of Jon having to convince people timber is a good idea people will come to Jon saying "Can we have a timber building please?" as a starting point. Many of the stories that I know about timber buildings the timber aspect of it has come about not because of any sustainability agenda, but because it's cheaper or it's faster and faster means cheaper or more profit or something. So there's usually an economic rather than a sustainability reason and that's not entirely a bad thing because I think when we work with timber we are actually going to end up with different designs and we shouldn't necessarily just replace steel and concrete buildings like-for-like and assume that timber will do the job in the same way.
	So in terms of what we or what I see as gaps we're actually not entirely sure where the structure of timber comes from. We know its properties quite well but which plant properties lead to which structural properties of timber is an open question and it's one we are actively trying to pursue and it's one that we think a clearer understanding of will give us more insight into how we can use timber more effectively in large-scale buildings.
	So there's structure, there's performance. I think there are two issues with the performance of timber: one is what do we actually need? It's actually a pretty good material but how much better does it need to get for large-scale buildings and then how do we get that performance? Is it a hybrid that's 10 years away because of whatever research hasn't been done yet or is it a hybrid that we can actually manufacture through mixing timber with steel or other materials? I think there's a tendency to think that timber buildings have to be all timber buildings or else they're not timber buildings and Jon and Simon and Adrian and others would probably agree that you can't have anything all timber these days.
	Then there is this question of perception and I think the perception touch is something both Peter and Jon mentioned. I think there is a perception of forests as virgin havens of cavorting deer, which some of them are, but there is rarely a perception of forests as a crop and I think both are probably necessary if we're going to turn more towards timber. There is also probably increased supply available due to decreases in other uses of forests, paper pulp is less used, but those trees which are grown as a crop probably ought to go somewhere rather than just die standing.
	So there's the perception of the supply and where it comes from and how we use it and there's perception in buildings. The two most frequent questions I get asked are "Is a timber building going to last and when will it burn down?" Both of those are much more perception problems than they are actual problems of engineering or design. Massive timber buildings don't burn by and large, they don't burn any more readily than any other material and in some cases they burn less readily and as long as they are detailed well like any building should be and kept relatively dry and insect free they will last for hundreds of years.
	So that is very much an area that needs work but not in a structural engineering sense, it needs work much more in a philosophical, behavioural sense.

	So the next generation of research I think is looking at those. One is looking at how do we change people's perceptions of timber as a building material and it certainly used to be the main thing we turned to. And the perception is global, in Spanish the word for building material does not include the word for wood, wood is not one of those building materials, so it's a substandard thing basically you build out of because you have to or you can't afford anything else, that's the sort of perception we need to change.
	The research questions in modification of timber, how do we do it and it's interesting to learn from here about the plant breeding or lack thereof in timber, because I think there's probably quite a bit that can be done from biology through to chemistry and if we can understand the cell wall contribution to the overall structural strength of a building what can we do? Then from an architect's and engineer's perspective I think timber buildings probably should be designed in a fundamentally different way from steel and concrete buildings and that's a problem…well it's a good problem, but it's one we need to tackle both in architectural and engineering consultancies but also in teaching and training the next generation of architects and engineers, because if the first time they encounter a timber building is when the client asks for one it's going to end up looking like a concrete building and that's probably not the way we're going to get the most effective change.
	So I guess I would add that the last thing is both a research and teaching gap and hopefully aspiration. So I think I'll leave it there. Thank you all.
PL:	Thank you very much Michael and thanks to all three of you, that was a very interesting set of points and I think we've heard many interesting comments. I'm sure lots of people have questions but first of all we've asked Simon and Adrian to say something in response, so perhaps we'll do that and then we'll open it up a little more.
SS:	Thank you Paul. Thank you Peter, Jon and Michael. So I'm going to start off with the resource and Peter told us that actually we're getting quite good in the UK at producing forests, creating forests. We are still quite in love with them as places of leisure and they are sort of holy and we shouldn't cut them down and use them but I think Michael will create a bit of a stir when an American comes to England and says our forests can be used as crops. But anyway, in terms of our UK forests one of the things I as an engineer found fascinating about our forests in the UK is that our forests in the UK are more productive than our cement and steel industries and UK forests produce around about 11 million green tonnes of timber a year, or they did a year or two ago, and our steel and concrete industries, or rather cement industries, steel produces about 8 or 9 million tonnes of steel a year in the UK and the cement industry about the same. Having said that our world of construction is all about concrete. Concrete uses by far the most materials in construction and in fact we even put more steel in our concrete framed buildings in terms of reinforcement than we do in steel framed buildings. Anyway, I'm an engineer, I like my numbers.
	Moving onto Jon. Jon, I think Lend Lease, you probably didn't shout enough I think about Lend Lease and what they're doing in a certain part of London which is Elephant and Castle where they are and have been for a couple of years now championing the use of cross laminated timber and building quite massive buildings out of timber. No other developer I know has taken that charge. I think this issue around people's perception of timber as a building material is one that needs to be tackled. The problem we have with wood, with timber, there's two names for it, but is that it can be used for windows, doors, chairs, joinery, anything and it's just confusing how many things it can be used for and it's difficult to grab hold of an industry that produces so many things. At the last count there were something like 30 different associations dealing in the UK with the use of timber and of course that sort of diversification doesn't help promote timber in any sort of way really, in a coherent way in my view.
	Moving onto Michael. I've talked about forests as a crop or trees as a crop. A new era of wood architecture sounds fantastic. In that research that Michael and Patrick and I

	were looking at or a paper that we've written, the idea that we are now building wooden buildings essentially mimicking either steel or concrete is not surprising when you consider that the Iron Bridge which was the first major structure out of iron essentially borrowed carpentry joint details to make it work. But that evolved and quite rapidly.
	I'd just like to finish on a couple of things before Adrian takes over. In terms of the construction industry it is changing and it needs to change. The UK imports something like around about 25% by value of all of the stuff required to build our buildings and infrastructure in the UK. We are an importer essentially, it's growing, we are one of the world's biggest importers of timber but even though we import huge amounts of timber we still only use about a half of the volume of timber per capita than countries like Germany use and only a quarter of a country like Finland.
	There is as a society, as a culture in the UK it's proven out there that we could use more wood and timber as a society per capita, we could double it quite easily and still be around what European standards are if that makes sense?
	Our construction industry suffers from skill shortage and it suffers to a certain extent from still thinking about buildings being crafted on-site, constructed or crafted or moulded on-site. Some of us around the table think that buildings need to move more towards manufacture, that's another new way of looking at things, it's something we've been tackling for many years but in my view wood, timber is in a perfect position to become a material that can be pre-manufactured. We are little bit obsessed with taking timber, cutting it up into lots of little pieces and glueing it back together again to make it a material that we can understand and is quicker to design because it's not so variable.
	But I'll leave you with one thought and that is - and I might get my numbers wrong here Peter so please correct me straightaway because I might be a factor of 10 out, it's dangerous ground here - but in my mind I had a photograph, an image of a forest in North America where as far as you can see there are dead trees and that is a beetle infestation and we're talking about volumes of timber in the region of hundreds of million cubic metres of timber I believe.
PF-S:	An area about the size of the UK. Something the [inaudible 0:48:20] calls Mountain Pine Beetle.
SS:	That's right, yeah. When you think what you could do with that timber if you chopped it down very quickly before it all rotted away and used it to build buildings or if you could do your calculations you could build all of these houses that we're supposed to be building in the UK for many years to come just using that timber, I mean it's phenomenal, it's about three million homes a year that you could build with this timber for the next 25 years.
	So I'll leave you with that thought. I don't think I'm a factor of 10 out Peter, but anyway, I will pass over to Adrian now.
AC:	I suppose I come from this from a fairly narrow viewpoint of an engineer and I kind of got very interested in timber as exploring broader influences on what engineering can provide but it's still quite focused on a process of design and understanding your limitations through the construction process and then how people inhabit buildings. That's a fairly narrow focus because we've got upstream forestry benefits and we've also got, we've not really talked about the downstream, what happens to the building at end of life and the benefits of timber in that and how do we design property for that. So there's one bit missing from that overall analysis of life-cycle and we've talked about the upstream benefits but what happens downstream as well, so I'm particularly interested in that and how would we advise on that.
	The question I'm asked, and we talked about buildings, is how much could we make in timber? So there is a broad forestry supply issue and I live next to Alice Holt Forest and I see lots of cutting down and experimentation on timber there but I think that goes into

	product and also paper and pulp and also biomass. So when we're talking about the needs of forestry it's not about the particular areas that we solely focus on in engineering and building things with product, but there's competing supplies on timber and where it goes so the 40% of needs, what are those needs? Are those needs of the structural industry, are they in the needs of the growing emphasis on biomass as an alternative fuel source, are they for our appetite for paper despite the digitalisation of society? So those are all competing influences on forestry but I have the exam question which is how much could we build and still be sustainable in terms of overall management of forestry? So what's the total capacity, either in Europe or in the UK or elsewhere in what we can build with this material with all those competing needs? That's my exam question that I'm always asked and I'd love to be able to answer what it is.
	Form follows function but it also follows finance. So there is in the way that buildings are done we have to demonstrate as engineers that they not just stand up but there is a whole series of these broad performance issues: fire, acoustics, dynamics. These are all really important issues to get right and timber has a different set of qualities in those areas. So we are learning how to deal with all of the interfacing layers of the building and all those performance issues coming together. That's actually why I find it really exciting as a material to work with because we have to deal with that in a coordinated multidisciplinary way. But equally we need the supply chain to be able to understand and implement it in an understandable way as well. So when we get to using timber it takes an awful lot of - not just design skills but implementation skills to actually use it in an effective way and produce a product which is effective for performance as well.
	I was at a lecture given by Barbara Lane on fire recently and there was an absolute fascination with the fire services on how do you maintain and alter timber buildings because they see people cutting through vapour and fire protection issues and thinking this is just going to be a massive risk. So when we talk about timber in buildings do we actually know how to use them properly and maintain them properly and inhabit them in an effective way, because the fire service seem to believe that it's just a massive risk for them. You put your flatscreen TV in the wall and you cut out a section which is actually supposed to be the fire stop, so what happens later on.
	So there are some really just fairly fundamental and practical questions to deal with in the use of timber, but equally there are a myriad of different types of timber frame that we can use. In structural engineering it's focusing quite a lot on heavyweight massive timber, CLT, laminated veneer lumber, all the stuff that is glued together, but the demand in the UK is probably for lightweight open frame systems which have a completely different set of characteristics and actually there are issues to do with perception and the reality of their performance, not just in construction stage fires but also in performance fires.
	So we should not underestimate in my view the reality of some of our lack of understanding of the performance of timber. We know an awful lot about timber in fire, but we also don't know an awful lot as well about the performance of glues and delamination of elements etc. So we should recognise those issues and actually there is a really fertile research agenda in timber on a whole series of different issues which could be explored which I think come back to the opportunity of designing and building in timber which is to find realistic ways to actually overcome those and people to learn from them.
	So although I'm enormously fascinated by the opportunity in structured timber at massive scale, but I know that the reality is for us to learn and progress is probably at the more marginal scale of medium rise seven to 12 type storey, that's where the bulk of buildings is done. So we focus on awful lot in trying to push that on incrementally to learn and also learn with the trades that we're working with. So their background is interesting also, not like Germany or Austria where they have a legacy of history of carpentry, 65% of the land area of Finland is covered in trees, they've got a lot to go with. The same with

	Germany, they have an association with timber which is slightly different than our association I think in the UK and how we understand it. So lots of our contractors have come in from a steel or concrete background and adapt into timber, and that's why they put it together using bolts and plates, not sticking one piece of timber on top of another one as it should be done. So I agree that we need to learn the language, but that's in construction as well.
	I could go on a lot actually, there's just so much to talk about and we will go on. There's a happy confluence of motives that come in successful building design that's about, so I don't necessarily agree it's a contractor's…it's a design team's aspirations to do it or it's a financial motive. You don't often see people talking about sustainable project examples which weren't successful, there's always some sort of happy confluence which makes them successful which is either, I don't know, some way of navigating through the aspirations of design and the reality of delivery. So I always think that it's a bit of a moot point to me about which one is done, as long as it's done in some way and moves the debate on. So I'm not as sold about it's a commercial issue or it's a design issue, but somehow that we navigate that as designers to come up with…just making some difference and making something a bit better and I do truly believe that timber allows us that opportunity and that's why I kind of follow it.
PL:	Thank you. You've both been fascinating. I think we'll have a couple of questions or comments from around the table and then we'll have a break for coffee, so if someone wants to…Peter, do you want to kick off?
PG:	Well I'm just having a very good day. I've met some very interesting people before I came here and now I've heard actually sort of five, if I may say, brilliant presentations, so my head is full of it. I spent yesterday at a timber frame manufacturing company so I'm all over timber suddenly.
	So I just wanted to raise two issues Jon you mentioned rather in passing, so I'll bet you'll regret it now, but buildings are going to be built for maybe a hundred years, but actually the truth is they're not. Most buildings don't last anything like…the buildings we build now don't last anything like a hundred years. During the week I live in a flat in Cambridge which is timber frame and brick clad because nobody wants to actually see the timber that everybody is so nervous about, then at weekends I go back to somewhere near Alice Holt Forest and live in a timber frame building from the 16th century where timber is just doing fine.
	But the hundred year lifetime, because I live near Basingstoke, most of the buildings that were up when I moved to Basingstoke in the 70s, commercial buildings, have now been torn down in favour of new commercial buildings. So we've now got 40 or 50 year life buildings if you're lucky, and so the deconstruction phase now I think is really important and we completely, largely completely ignore it. One of the issues with timber is that we are the only country in Europe I think where we insist on pressure treating softwood timber with pesticides which make the wood hazardous waste when it's disposed of. All the other countries in Europe don't have that problem, they say if you treat wood properly it doesn't need those treatments which makes its deconstruction and its re-use much more attractive. So I think there are some big sustainability questions about what we're doing with timber now which leaves a legacy for future generations.
	The other sustainability issue that I wanted to raise was that I think several people mentioned the UK ability to deliver timber as if local timber was better than timber from Canada or Australia or Indonesia. The trick is…I mean Canada ought to be taken to some sort of court for the way it deals with its timber because it doesn't replant and it doesn't join FSC and it's really…you think of Canada as such a nice place but they are really bad boys about timber. The shipping costs associated with timber are such a low part of the carbon footprint of any product arriving anywhere, particularly bulk products being shipped, that it's just irrelevant. If the timber is better coming from Germany,

	particularly if it comes by ship, or from Indonesia or Australia or Canada then its distance from where it's used I think should be regarded as largely irrelevant. All of the carbon is invested in the last 50 miles and often in the last 10 miles.
	So I think that it should be regarded as a global resource and we should get away from this idea that local is necessarily a good thing.
JK:	Just to reply on that point. From my understanding of the British sawmilling industry it's only a small percentage of the global market as you quite rightly point out, but what it has is its ability to - and you see a lot more of this in most industries now - that just-in-time supply chain. So you've put your timber on a boat from Canada or from Latvia and it comes across and it's in a certain size, it's been already milled and it's arrived here on the dockside. If you don't want that size you have to buy it and then you have to re-mill it and lose, waste whatever proportionate it is in the size that you want, whereas the advantage of our local millers is you say to them "I want this size", and they literally make it to the size you want and then you get it. That's the niche and in some ways they will always ever be a niche compared to those huge suppliers, that's the market they really have carved out for themselves particularly well.
MP:	I agree with that.
JK:	I think just in response to that I think you are exactly right and I think my words were it was hoped to be up for a hundred years, so I recognise it won't be, but that is the dream, could you build a building that people will want to live in or work in and it still be there in a hundred years and the reality of that is from my perspective it's actually not about the building material, it's about getting the design right in the first place, is in the right place. That's partly why a lot of these buildings are being torn down right now is because as we've evolved through time in terms of utilising this space the buildings are the wrong shape, they're the wrong size, they don't fill the need that is actually required so the quickest and easiest thing in theory is to tear it down and start again which whether you agree or disagree with, there are pros and cons to that.
	But you're right, I think we're not designing buildings properly in my view in terms of long-term scope, we are definitely not designing buildings to be deconstructed at the end and my big hope at the moment, particularly as the drive towards BIM and the move in terms of computer modelling of buildings is we have a better understanding and inventory of what's in a building and actually will help us going forward when it gets deconstructed in terms of what can we use that for. So I think we need to definitely be driving in that direction.
	In terms of coming from around the world I think effectively we live in…I think somebody once told me we live in a 27 hour society, you can get anything from any point in the world to anywhere else in the world within 27 hours if you're prepared to spend enough time planning it and actually spend enough money on it. So we are really looking at a global market now in everything. Whether it's door handles from China onto a project or whether it's moving an elephant from one zoo to another, with enough planning and timing you can make that happen in that sort of timeframe. I think the reverse of that is it is incredibly easy to transport around the world via ship and I think that will be happening more and more.
	The problem in for example the building we built in Australia is not necessarily that the actual timber came from Austria, it was the fact that that was where the sawmill, the expertise, the CLT industry was, is there a case for picking that up and moving it around the world and then start asking the question around the timber. So yeah, carbon comes into it but very small, for me it's very much the social impacts of actually what does the entire industry mean moving it from one place to another. But without a shadow of a doubt we are building buildings without really thinking it through and we are doing it with very short-term logic. Some of the most successful buildings that are in existence for hundreds of years are ones that are more adaptable to change and you can change

	things. It's very hard to do that in some cases with a timber building where you've got solid walls that you are relying on the structural elements, you have to design that kind of flexibility from the outset and very few people are prepared to do that. So it's an interesting challenge, definitely.
IH:	Can I ask a question about resource intensification or the increase in production? Because I guess it's interesting, I mean there's a question about why forestry lags behind, whether it's a technical thing or a social thing or just a lack of investment. I guess I was wondering too about ecosystem services, so I guess eucalyptus suggests, as you say, that we can increase production per unit area or something, what's the cost in terms of loss of ecosystem services or ecosystem disservices? Does it just then become a production floor that actually has no other value at all or what are the potentials? Or can we create different sorts of biodiversity that would go into these, so we have intensive production of biodiversity to go into our intensive wood production?
PF-S:	Yes, I think that last point is really what I would say, that the monocultures of eucalyptus which are still very unpopular, just actually as we have a problem with the monoculture of Sitka spruce in the uplands, that is a genuine issue. In the paper that I sent round the new category of plantation forests was intended to move on from that thinking, so a planted forest which is a combination of the naturally occurring native species and introduced species to actually achieve much more what we have in the UK lowlands, that's a managed system which is managed for the full range of ecosystem services rather than predominantly one of production. That's quite a significant progression of thinking and actually it links to the certification side and when we think that it's somewhere between 4% and 10% of the global forest area which is under any form of certification scheme it makes you realise how far there is to go.
IH:	So is there a question about flexibility of thinking? Do we need to think different biodiversity? So we say well there's certain sorts of species that we would lose if we lose our forests, but maybe they've only been there for a few hundred years so maybe it doesn't really matter. There's no one else…we're not biodiversity people here by the way.
PG:	We'll tell!
IH:	Sshh! Nobody is listening. I guess to some extent climate change is going to change this anyway so there is no good saying "This is what we've got now" because it's going to be different. So is it a matter of in a sense designing forests or designing natural, semi-natural, non-natural, I don't know, designed environments that would actually deliver perhaps different biodiversity that maybe fills similar sorts of niches that pre-exist in biodiversity. How much scope is there for something which…?
PF-S:	That's what the ecologists would call functional diversity, so it's sort of being concerned about which species are present, you're concerned about the way the ecosystem is providing ecosystem services and in global terms if you're worried about carbon cycles and climate change and water management then functional diversity is the way to go. I'm not sure we've bought into that yet very comprehensively at the sort of public understanding side.
IH:	So what would we need to know or what would we need to explore to test those sorts of things?
PF-S:	Oh for me you've said it in the beginning actually, the last comment that if you know the climate is going to change there is actually not going to be a natural ecosystem which is the same as it was a hundred years ago. So whether we like it or not we are in a managed environment and then you manage it for the ecosystem services that you want but you include in those conservation, recreation and landscape, so natural capital.
JK:	I think there is a severe lack of understanding in the general public around ecosystem services and the benefits of it and actually the values. I think it's very easy for us to

	understand commodities travelling around the world, whereas when you have a service which is a service that is essentially free, because that's where people perceive it as, be it fresh air, clean water, whatever it might be, it's very hard to put a value on that and therefore get people's head around that. Therefore it's hard to, dare I say it, make the business case for actually the support you need to actually get that sort of programme off the ground. So the question mark is how much do we actually have to change people's perception and I think that will happen naturally over time in terms of the climate, as you were saying, I think people will be forced to understand the benefits of flood risk and all the other benefits we get from green infrastructure and I think that will change. But I'm pretty convinced we need to drastically pull that forward and I don't think we've got a full understanding of how we actually explain those values to people in general. It worries me.
PL:	I think this has been a fascinating conversation. I agree with Peter, it's been really educational, I've learnt a huge amount but I think we'll just take a 10 minute break for a cup of coffee and stretch our legs and we'll return. We have a couple more people to respond and we'll have more discussion before dinner.
	After Coffee
PF-S:	…sufficient community to minimise biodiversity loss by accepting that we're going to have increased use of resources in the future as the human population expands and each person uses more and more resources. There have been some very interesting conversations about this because I've been to a couple of forestry practices over the last year which really contrasted and one was in Finland, I went there in February, which was cold! They have remarkable forestry going on in Finland. They have two people running these two vast machines, one of which is a sawing machine and one which takes these logs away. But they'd really thought through how to manage their forests to maintain a diversity of forest structure, so there was big trees left for birds and bats and other things, keeping the logging area small, working out how much nutrients were going to go back on the land after they'd withdrawn the wood and so forth. Really very, very well thought out but very, very frugal economically forestry. Of course that's also happening in a system which has got very little biodiversity in it, there's just a handful of tree species in these systems.
	So that's one example and at the other end I was also in Malaysia earlier this year as a part of a huge NIRP project I'm a part of and over the last 40 years the lowlands of Sabah where I was working has lost 45% of its forest cover completely and almost all of the rest has been logged and then logged again and then logged picking out all the valuable trees in a completely unsustainable way. That was made possible by a lot of the land being owned by government company and they have a lot of sway as to what happened there. So it's very interesting hearing the conversations around this because I really like this FSC and these initiatives to look at how these very diverse tropical forests which have got so much conservation value, not only in terms of biodiversity but in carbon storage, how do we look after those in the future? How do we get the balance of plantations in the tropics and in the temperate world right because these eucalypt plantations in the tropics can be extremely productive compared with the neighbouring old grove forests. How do we make sure that we preserve some old grove forests in these tropical landscapes and maybe allow production forests in a sort of sustainable management of the natural forests.
	So that's what interests me and it was very interesting to hear the different views on that across the table.
PL:	Thank you. Actually before we move onto Paul I just want to…I should have and forgot that I've to introduce Bea or get her to introduce herself because she didn't have a chance when we went round the table.
BS-R:	Sincere apologies that I was late for the start of the meeting. Beatrice Schlarb-Ridley,

	I'm one of the original co-founders of the Centre for Natural Material Innovation, was in Plant Sciences and previously in Biochemistry, I've worked with Paul Dupree on the bioenergy initiative before moving to the material use of lignocellulose biomass, but last year jumped ship and now I'm director of Innovation Impact at the British Antarctic Survey. Still a very, very strong interest in this area and we've also just finished our timber frame passive house we're living in, so personal interest in this. We are experiencing the living building as it moves and the paint splits here and there and adjustments are necessary. It is interesting to have a living example.
PL:	Thank you Bea. So Paul?
PD:	Thank you. I found this discussion really very interesting as well. I'm also part of the Centre for Natural Material Innovation with several other people around this table. It's a relatively new centre so a lot of this discussion is new to me and one of the things that I've found surprising about this discussion now was the apparent drag to increase the use of wood in construction from so many different perspectives, because I had entered this thinking that everyone loves building their house out of wood and wouldn't this be an easy thing and so perhaps one of the things that really struck me.
	From my academic perspective as a plant biochemist I've been thinking about how we might improve trees for these types of applications and I was very interested to hear about the proportion of wood that comes from managed forests which could potentially over time be replaced by bred trees and so there's a potential for changing the type of feedstock that you might use in the construction industry.
	I have a little bit of experience of Brazil in the past…currently I work a little bit on bioenergy and sugarcane which is a big industry in Brazil, but they have a very large industry as well in forestry, particularly eucalyptus and there as I understand it, and others might know better, they are moving towards intensification of this on certain parts of the land, but also reforestation alongside the farmed eucalyptus trees. So in São Paulo area they have to reforest with native forest a certain proportion of their plantations. So I think that to me sounds like a good model for the future of having both the ecosystem services, these are planted around the rivers for example, and having some of the land where you grow the tree which is devoted to your product, it might be interesting to hear if others agree about that. But these eucalyptus trees grow enormously quickly, they can be harvested within seven or eight years of being planted. I think it's not so good for construction, this is mostly used for cellulose and so as a plant biochemist then I'm interested to know what others think about the potential for improving the output in this type of system. There will be faster growing trees developed. There are faster growing trees being bred and genetically modified eucalyptus is on the horizon, it has recently been approved for planting in commercial plantations in Brazil in the last month or so and I hear that there are trees now which will grow twice as fast so they could be harvested in four years let's say, so look forward to a very exciting time. But I'd like to know and understand better, this is one of the targets of our centre with Michael, understanding what properties we need to improve in these trees to make them better for construction or do we need to think about new species of trees perhaps and maybe eucalyptus is just a non-starter for construction.
	That brings me onto another aspect. In Brazil it's a very special case of trees growing enormously quickly, in northern Europe trees grow very slowly and I wonder, given the time it takes from planting of the tree to harvesting of the tree whether there's really any potential in our lifetimes to change the feedstock, or is this not really something that we can envisage.
	Those are my thoughts.
PL:	Thank you. I have to declare an issue, I'm also a member of the Centre for Natural Materials Innovation and coming from Australia when I moved into my house in Cambridge and you're right, they grow bloody fast! I had to cut it down very quickly

	because it took over the whole place. Anyway, so, but I was going to pass onto Gemma.
GC:	Thanks. I have one reflection and one question really. My reflection was on the conversation between Peter and Ian about functional biodiversity, I've never really heard it called that before, I really like that terminology and it was really a reflection on a company we're working with who is a paper and pulp producer and they are really nervous about being absolutely caned for plantations and the management of that and the knock-on effect. Rather than putting the biodiversity into little separate land spare and share type of approaches they've taken what they're calling ecological networks. So they're looking rather than just at the plantation itself they are looking at the whole landscape and trying to see what the positive and negative consequences are of that plantation through the biodiversity and whether they have a nice corridor around it or whether there's flood protection, not just for the company and the extraction of the fibre coming out of that, but also the other stakeholders as well. So that was a sort of a 'don't just look at the forest itself but maybe look at the larger landscape as a reflection.' And my question is completely and utterly left-field. When we talk about regeneration and all that kind of stuff we instantly think new houses and new structures and wouldn't it be lovely to have a house made completely out of wood. Is there any potential to retrofit? So given the stock of housing that we have currently is there any possibility to improve them with a timber resource rather than more metal struts and other things like that? I don't know, I'd be really interested to hear what the options are, if it's possible and if that's a good or a bad use of that resource.
MR:	So I can say little bit and others can as well probably. So specifically on houses maybe less so, I mean I'm sure there's opportunity but houses tend to be individually owned and therefore it's very much based in what the owner wants to do. Whereas large-scale buildings are usually owned by companies and the drivers are very different. And what we do know about timber buildings is that they are significantly lighter than steel and concrete buildings, that's one of the benefits and drawbacks because they wobble in the wind a bit more and so is that good or bad, do we care and how much is very much open to research. But because they are so much lighter you can actually stick them on top of existing steel and concrete buildings without doing much or anything with those buildings. So there are and there have been a few actual projects and a number of proposed projects of extending existing tall buildings to make them significantly taller by doing it in timber. I think there's one in Amsterdam where they took one or two concrete storeys off and added eight or 15 timber storeys, I mean it's that scale of difference. So timber does have the potential for some significant either additions or in a very crowded city like London if you have to tear a building down you can reuse the foundations if you put a lighter building on it. If you put a heavier building on it you probably can't because you don't know how strong they are but if you guarantee that your building is going to be lighter than what you took away you're probably okay. Then this becomes much more of an insurance question than a structural question because it's probably almost always guaranteed to be fine from a structural engineering perspective as long as things haven't moved much in the last hundred years they're probably not going to move much in the next hundred years, but that's not what Zurich wants to hear.
DC-B:	Paul, may I ask a question? If we are in the general question time now.
PL:	Yeah, we're in the general question time now.
DC-B:	I suppose this is more for Michael given a background in architecture. So natural materials and you mentioned the idea of timber as a natural material let's say. I remember Frank Lloyd Wright arguing that Fallingwater was his most natural building and of course it is due to steel and concrete, but when he talked about a natural building he meant its form, its texture, the fact that it was embedded in the rock and so forth. So I mean how much do you think the stimulation of a sort of market in timber buildings requires this thinking that it's a natural material and how much of it is just the sort of engineering characteristics of wood?

MR:	That's a great thought-provoking question. I mean I think certainly in terms of Fallingwater you're absolutely right, it's the setting is what makes it natural rather than the materials because it's mostly concrete.
DC-B:	And the embeddedness of it in the setting.
MR:	Well in terms of material it's concrete and it's been redone at least once. But absolutely, the setting makes it a very…makes it a natural building even if the materials aren't natural.
	I think in terms of what we're thinking about we're looking at the materials as the basis for a series of buildings that we might actually describe as not that natural because they are urban. We're looking at urban buildings and natural materials for buildings that probably aren't…we wouldn't think of them as natural buildings, they're just urban. I think many of the examples…there's the tallest timber residential building for a while was in London at eight storeys, called Murray Grove or Stadthaus depending on which name you prefer and there is zero way to tell that is timber building unless you look at the plans. No timber is exposed and the timber starts a storey up on a podium of concrete and that's actually…I mean Ian can probably say more about that job. It's quite common for timber buildings is that clients and as we heard earlier the Fire Brigade don't want to see exposed timber, either for real or perceived reasons. So I think I would say that we are looking at natural materials for their potential benefits but not necessarily for their potential output as we look at these and we think 'Ah', I mean that's…then we can get to those questions about behaviour and health and are they better which is a very interesting area but we're going to have to expand to do that. We're looking at how do you get the building built at the moment.
JK:	I think just building on that and picking up the points you were saying earlier on I think I totally agree, I think there's opportunities to use timber in a sort of commercial type scenario, whether it be retail or going into the office space. In terms of residential it's very hard, particularly in the UK context because the concept of an Englishman's home being his castle is still very heavily embedded in society and that castle is made out of brick or it's made out of concrete or hard materials and we do struggle on that. If you are building an extension to your home it will probably be brick, it probably will not be a timber frame and part of that is tied up in the planning, part of that is tied up into what that looks like and we do have a habit of trying to cover all this timber in brick slipforms or whatever we go down that route for because we don't want to see it. Even when we built Forte in Melbourne which was the next tall building in the CLT story it was on top of a concrete podium, mainly because we needed a flat level to build it on, but yeah, the entire building was then clad in plasterboard and all sorts of bits and pieces. We actually had to fight to get a single wall in each residential apartment actually exposed because the marketing team were like "Well we're not going to be able to sell it if we actually show timber." So even just having a feature wall just to give some interaction with the building and show that it's made out of CLT was hard work from a commercial aspect. And I think there is a balance, I think you can go the full direction in the opposite direction and expose so much timber it just looks like a Swedish sauna, so you've got to be careful for that. But I still think there is that interaction with timber that we can push for and change, but there is that perception piece, particularly in a residential market where they just don't want to see the timber which is scary really.
PL:	Henry?
HB:	Would the marketing team that sold the buildings with the exposed wood wall, would they still tell the same story? Would they still be worried about selling a building or has history proved that they were easy to sell because of the exposed timber or were they genuinely hard to sell?
JK:	The problem you have is it becomes almost anecdotal in the sense that you sold it but why did you sell it? Was it actually because of the exposed timber or was it because it

	had a fantastic school next door and that's really what the owners wanted?
	So it started from the point of well is it a bad scenario? I mean the reality is they sold quicker than anything else we've done in that area, they all sold I think to first-time buyers, people actively wanted to move into those spaces. So if you talk about the absorption rate of getting those units actually into the market quicker then there's definitely a market for it and I think marketing will then start to pick up those stories. It can't hurt was I think the solution they came out of that. But that fundamentally was a fight to actually get to that scenario of saying "Well let's talk about timber", it just wasn't on the agenda.
DD:	I just wonder whether timber is an economically competitive solution compared to conventional building materials.
JK:	Yep, that's a nice big question.
DD:	And if not, because I have the…I feel that it's not and I know that the cost of timber framed and timber cladded passive houses is really high, so I wonder if it is to be a commercial material and commercial scenario is it economically viable and can it be?
JK:	So I think it can be. The problem is from our perspective as a construction developer it's comparing apples with apples and actually making it the right comparison. If you look at say CLT for example, cross laminated timber where we've done projects, on paper they don't stack up in terms of the materials, a solid chunk of timber is actually costing more than a solid chunk of concrete, particularly when we lay on the fact that we demand FSC timber and it's got to be certified and that's…there seems to be almost a blank cheque there from sawmills and… "Oh you want it certified? Okay, well that's more expensive." So there is that added cost that is self-imposed but we do do that. The problem is you can't think about it in the same way as you think about concrete. You can't think about it in the same way as you think about the actual method of construction. You need to look at the whole building and actually the way you build that building and the reality is if we took cross laminated timber for example it goes up quicker, you need less people to do it, you need less people manning the site in terms of washing down concrete trucks. It's not as noisy with the neighbours because it goes up so quickly. When you factor in all those other benefits and reduce the programme it actually works out cheaper, but if you only look at it as building material against building material it doesn't quite stack up for us in terms of the way we actually construct buildings, but if you recognise that you knock a third off the construction time it's all those added extra costs you're saving by using that methodology that actually makes the building cheaper and a more viable product. But yeah, if you look at it timber frame against…or a construction like CLT frame against concrete it's very hard to make those numbers stack up.
PL:	And what about the whole life-cycle costs then of the building? If you did it for the whole…from the beginning to the end of its life in total?
JK:	So it comes back into the point we made earlier on in terms of what is a life-cycle of…draw a line on that. The problem we have particularly around timber is it completely changes the way you design and the approach you have and actually a lot of the cost we find is actually going back and changing a design that was already fixed at the beginning. You have to completely change your mentality when you're designing out of timber as opposed to concrete. Particularly CLT because obviously it goes into a mill and it gets manufactured in panels and it arrives on site and literally you just click it together on site almost. You have to do all your design prep and everything else upfront and it completely changes the way you actually build and design a building, whereas you've got far more time in a concrete process where you can say "Oh, I'll just move that pipe over there or I'll change that detail or that wall can shift", you can't do that with something like CLT because once the designs go into the factory that's it, you've got very little wiggle room. That means that we don't actually plan properly for the whole life of that project. You end up with a mishmash of walls being changed and so on. I don't think we've

	actually got to the position of asking that question yet in terms of what does it mean over the life-cycle. It comes down to construction timeframe, cost and getting people into that building. We as an industry aren't there yet, we're struggling to get timber and CLT onto the agenda let alone trying to justify its use in terms of being up for X amount of years more. It's a tricky one.
IH:	Can I just follow that? So if you then factored in the social cost of carbon, I mean if you then say because you're taking carbon out of the atmosphere and then compare it with concrete which is going to put carbon into the atmosphere, is that going to be a significant factor in this comparison between building type or is it too small to be?
JK:	I think individuals such as yourselves around the table that understand the benefits of locking away carbon that's useful, for Joe Public buying a house it's probably not up there yet. It comes back to the ecosystem services question we were talking about earlier on, what is the value of locking carbon into your home? I'm not sure the average resident buying a house tomorrow actually recognises that. What they are starting to recognise quite quickly is the cost of fuel and actually what it means to heat a home and when you can start moving down arguments like actually CLT allows you to build to almost passive house standards or eco house standards you've actually got a property where you can actually getting into zero bill homes, it doesn't cost you anything to heat your home. That's very much on the agenda of what people are recognising and I just don't think that Joe Public or the market, whichever way you look at it, is advanced enough to recognise it's an added benefit, it's a nice to have.
IH:	Well it is a public policy question presumably? That if society would like it done then I guess the implication is that if homeowners don't recognise it then the policy ought to be rejigged to try and create incentive for homeowners to take it into account.
JK:	Absolutely, no I'd agree with that.
PF-S:	If you do the life-cycle analysis with the limitations you've already described actually, the waste, the deconstruction costs are normally not in them, but if you do them from the forest through to the utilisation then that substitution of wood for concrete is a massive carbon benefit. It's probably the biggest carbon hit you can achieve, but there are limitations [inaudible 0:25:00].
MR:	But I think Peter your point is essential in its the substitution. So it's replacing carbon with that steel. If you just look at timber and the amount of timber that we use it's quite a small percentage of the carbon factor.
PF-S:	It's the carbon cost of making concrete.
MR:	When you don't make the bad stuff and you replace it with the better stuff, that's where the real gains are.
SS:	I think there has been exploration of timber as an allowable solution or alternative to renewable energies, I know Stadthaus [inaudible 0:25:33] is one way of saying well we'll put renewables on the roof because we've got all the carbon stored up. But I don't believe that there is any traction at the moment from government, whatever government that is, in strategically allowing alternative lower impact materials as a basis of a more holistic carbon reduction strategy. So there's no kind of financial incentive for others to make it stack up in commercial terms against current norms and I suppose that's a bit disappointing that materials haven't risen up in a carbon agenda to produce some holistic idea of total carbon which goes much broader than just the building level. But we haven't even got to a point where whole building carbon is about total material and energy consumption in use in reality. So we've got a long way to go until we can actually find incentivised production, inclusion of timber and/or other biogenic materials into buildings and that's a pity.
RA:	If timber buildings did become as popular as they could do is the wood there to be able

	to supply that in mind or is it a little bit chicken and egg in the way that you're developing materials for timber buildings based on what's there already or is there going to be a need for a different mix of species to be able to supply the wood that you need for buildings?
SS:	I think Peter could probably answer this with the forestry association. If you look at it in Europe, if you take Europe there are many, many cubic metres of timber that aren't harvested each year, so the forests of Europe over the last decade have grown a phenomenal amount in sort of landmass. So in terms of a resource we're not using everything that grows, so a huge amount more could be constructed out of timber and I did do the figures once, it's mind blowing how much could be done, but you can't do everything in timber.
PF-S:	That's the point you make about the Mountain Pine Beetle. If you leave trees to rot, if you don't manage your woodland then that carbon goes back up in the atmosphere. If you harvest it and substitute it for concrete and cement etc that's a major carbon gain. Now I think seeing in that context is really important.
PG:	I don't like to spoil the party but the carbon benefits of timber can be…are generally overstated because there's quite a lot of carbon associated with the processing of timber, particularly when you get to manufacturing products like CLT and BSP [inaudible 0:28:43], because there's a lot of kiln drying, there's a lot of processing to get it to the mill, there's a kiln drying process, then we insist on impregnating it with hazardous materials and so there are issues around the carbon balance between concrete, steel and timber which are not just straightforward, it's not just simple. The point about leaving woodland to rot is really important because if wood rots it doesn't emit CO2, it emits methane, so it's a really good idea you've got a tree that is going to rot burn it quickly because methane is 23 or something times more damaging as a greenhouse gas than CO2 is. There are lots of…it depends how complicated you want to get, but I think as you were saying Adrian the issue about essentially the carbon associated with the construction of a building, which has previously been seen as almost irrelevant, as we start to build buildings which are fractionally better at using operational energy less, if we get to passive house standards or even halfway to passive house standards, the embodied energy associated with building those buildings becomes maybe as much as 50% or 60% of the total carbon associated with the operational lifetime of a building. So we need to have a very different conversation about what are we building with and what are we doing it for and are we applying a discount rate - this is going off at a tangent - but are we applying a discount rate for carbon. Because if we can build buildings now which save carbon in 25 years' time and over the lifetime of that 25 years it seems to make a lot more sense than leaving to future - which is what we've always done - leave to future generations the problems we create by externalising all the problems we've been unable to face.
SS:	One of the problems I see with the embodied carbon argument and the regulations. So buildings, we have building regulations in the UK and we regulate a number of things and one of those is energy use inside the building, but the embodied carbon issue for timber is a tricky one because as far as I can see it there is no incentive for UK to incentivise the use of timber or prefer it because we import most of our timber, and any carbon credits you can get for doing that, where do they go? They go back to the source of the forest which is in another country. So there's all sorts of problems with this global commodity of timber and embodied carbon and the perverse thing is with all of these CLT buildings that we are exploring still, it's sort of very early stages, is that most of the CLT buildings that we built started off as schools of two or three storeys and in engineering terms the stresses in those bits of timber they were hardly stressed at all. We could have built those schools in normal stick frame or stud construction and used a third of the amount of timber and given a leaner design. We are the same with concrete frame buildings, we use a huge amount of concrete in buildings, but someone else said it, not me, in fact an ex-Arup engineer, Chris Wise said "Actually a lot of the concrete

	frame buildings that we design, probably 40% or 50% of the concrete in there is not doing much." So there's this lean design thing and the whole thing about embodied carbon, and Adrian said it in the break, is you've got this perverse situation, if you [inaudible 0:32:36] people with building out of timber because [inaudible 0:32:38] sequestered or substitution, then you're going to be forcing people to put more timber in their buildings when they don't actually need it.
	There's no solutions there but it's an interesting discussion that we can just have a whole debate on embodied carbon.
DC-B:	Right so this may be a purely US centric question and it may also simply reveal that I haven't kept up with the literature, but in the Environment Protection Agency back about 15 years ago there was a big debate about whether we ought to be in fact extracting the wood out of forests or was it desirable instead to have this wood to burn when lightning came along. There was a big debate about whether it was desirable to actually have forest fires and the ecologists were generally siding on the idea of let it burn. Let it burn, it's going to replace the ecosystem, you're going to have growth. Is that at all here in the UK, in the EU, this feeling that you should just leave the stuff down there so that it will catch fire? I'm simplifying.
PF-S:	Well I think the idea that natural ecosystems need disturbance, whether that's fire or pathogen outbreaks, in order to be, that's part of the system and that if you start to manage them by extracting all the timber you are increasing the fire risk for example, that thinking is fairly prevalent now. So the classic one here would be wind throw which is a natural disturbance in temperate systems, forest systems, and actually we do quite a lot now to try to plant and grow and manage trees so that we don't get any wind throw. So there's thinking along those lines and certainly trying to take that into account in management.
PL:	Sorry, I don't know what wind throw means.
PF-S:	Just storm damage which is a natural disturbance more in forest systems, temperate systems.
WS:	May I just add a little bit to that? So I think there are some examples in Eastern Europe where they had wind throw events, lots of trees blown over by wind and they didn't harvest and then you do get the pine beetle outbreaks which were spread from the US where it went on to cause a lot more tree death in the surrounding forest. So there's an interesting question about how much this wood you leave on the landscape after windstorm goes through.
JK:	Just to go back to the fire piece I think obviously that comes down to good forest management, understanding the species and the nature and the ecology you're working with and obviously for certain forests you've got, in Australia or California and so on, you've actually got forests that effectively by nature are designed to deal with fire or actually need it in a lot of cases to actually keep the ecology alive. Obviously that doesn't apply everywhere around the world but that does factor in the concept of actually it's understanding forest, forest management practices and really doing what needs to be done. In terms of disturbance which is a classic example, if you don't have that through forest management practices then if it doesn't happen in nature you almost have to step in and make sure that happens. But it's crucial to understand where that timber is coming from and the context it's coming in.
	I just wanted to circle back for a quick second around the embodied carbon piece because I just wanted to pick up on one point. I don't want everybody to go away thinking that the decision to build out of CLT or stick frame or anything is reliant on embodied carbon, it really isn't, that's part of the debate, and those schools for example we were talking about quite often are built out of CLT because you can build them so quickly. They will actually go up in a summer break, a school can go away in the

	summer and come back in September in a new school because you can almost build them overnight. So there are a lot of factors coming in, whether it's speed, safety, a whole host of things that help you design and build that building and it almost ends up in a scenario where embodied carbon is a nice to have really. But I don't think we're there yet in terms of understanding the implications of that because we just don't understand the end of life conversation earlier on, whether we are actually doing the right thing. To the point earlier on about methane, it's exactly that scenario, are we creating a legacy that actually will cause a problem down the line, I don't think we know yet.
SS:	I was really fascinated actually, I did read some of the paper, about the role of temperate hardwood forestry in meeting new timber structure. So we worked on cross laminated hardwood using tulip wood from the States, it's a kind of very low grade material but super stiff and very strong actually and it had particular qualities in terms of requiring different glueing to make it. There's an advent of beech hardwood product now been produced in Germany because they've got a surfeit of beech forest that they want to use as well. So I was interested in the agenda for the Centre and how it actually…rather than modification at a cell level, does it also look at modification of the stock that it's using and that stream of thought about smaller, stiffer, elemental, using hardwoods? So you talk about softwoods, you talk about tropical hardwoods and those problems but there's got to be an intermediate one on temperate hardwoods which not many people talk about as an alternative stock. That was one part. The other one was rather than cell level modification is mechanical modification. I know we don't want to start having loads of reinforced timber elements but we're using very low-grade softwood in these engineered timbers and you can do an awful lot with a screw actually in reducing section size in terms of where the contact stress is or shear stress is at points. It's not normally the element which requires lots of strength, it's the connections between elements which are…so there's an awful lot that can be done and the codes are actually pretty blank in terms of what you can do in terms of mechanical modification of timber and there's a really fruitful research agenda there in breaking lots of stuff up with screws in it if you want to do that and that would be a really good thing I would have thought for the Centre to follow.
PL:	I think we're getting close to the end but perhaps if our three witnesses have a final thought we'd be happy to hear it.
PF-S:	In response to that last point make a couple of plugs if I may. There's a very good partnership organisation in the UK called the Future Trees Trust which is doing the hardwood breeding and they are thinking very seriously about utilisation of hardwoods. So it's a good set up - Future Trees Trust. We also haven't mentioned - I'm sorry, it's parochial with British again - the Grown in Britain campaign which many people around the table will have heard of. Whether or not you think timber should be grown in Britain what that campaign does do is integrate from producers' processes and users and I think a few of the comments we've made today have been about getting that vertical integration through the industry.
JK:	I think actually I would echo everything we've actually said earlier on, I think there's lots of people around the room made much smarter comments than I have. I will pick up your point though actually Adrian, I think the future is in hybrid technologies, I think it's mixing these things together. I think one of the biggest problems we have is this obsession with moving to timber means we have to do everything out of timber and that's not necessarily true in my mind. I think there's a space for it. The concept as what we were saying earlier on around do we have enough timber? I don't think we're going to stop using concrete and steel overnight and switch it to timber, I think obviously it's a logical progression, but I think there will always be scenarios where actually steel will work or concrete will work, it's where it's most appropriate and actually it's just putting it back on the agenda and actually having it as one of those tools in the toolbox, you can actually utilise timber. It's not an inferior product, it is a real product and actually it can be just as good as concrete and steel, so it's putting that back on the agenda and if it

	means manipulating it, working it, understanding how a screw can make a difference to that, that probably is the future of bringing it up to speed in terms of changing mindsets around timber in construction. I think there's a lot of work that needs to be done around the perceptions of timber and understanding how we can use it going forward, because it is lagging behind in my opinion in terms of people's understanding of what it can do and what it should be doing and the default position is always concrete or steel and that's a shame.
MR:	Well thanks to everybody, I've learned a lot and enjoyed it very much. I think one thought I'd like to leave with is even though we look around at our history and the history of other cultures and we see timber being used for hundreds of thousands of years, in terms of the type of work and the type of buildings that we're looking at the research is probably between 20 and 50 years old and that's in contrast to over a hundred years of concrete and steel research. So the history of timber use is very much use rather than research and I think we're moving into an area where we can use the research and the application simultaneously, both from a forest products point of view and from a buildings point of view to hopefully make some rapid progress towards getting more and better buildings built from natural materials.
PL:	Thank you. So Roz, did you have something you wanted to say at the end?
RA:	Yeah, so the next forum, we usually meet once a month but this one's come up quite quickly actually, it's on the 12th of May. So we're going from concentrating on a particular resource to concentrating on a region, so the next meeting is going to be about through an East African lens, bringing together a panel of people in partnership with the Food Security Initiative and also with the Cambridge Africa Programme to think a little bit…we've been asking lots of questions over the last year about the supply and demand for resources, the impact of that demand, where resources are going to be coming from. So next month it's really about looking at those kinds of questions within East Africa and looking at some of them for that region, hopefully with people who work in that region. So I'll send you some more details about that in a week or so.
PL:	So thank you all very much for coming. Particularly thank our three witnesses and the people who responded to them. I think it's been a fascinating couple of hours and I've really learnt a huge amount and enjoyed it and I hope you will now join us for a glass and a dinner and we can continue this conversation for a bit longer. Thank you very much.
	END OF AUDIO