TRANSCRIPT

**Program** – MSD Symposium

**Day** – Day 2

**Description** – Derailing workplace MSD risks through systems thinking.

**MADONNA KING:** Welcome back. We now have Associate Professor Anjum Naweed from the Central Queensland University who will present on derailing workplace MSD risks through systems thinking, which is front and centre of our theme today. Anjum has over 15 years of experience across a range of industry sectors, complex domains and occupational settings. He has a PhD in applied cognitive science and is a certified professional ergonomist. Anjum has co-edited books, has written more than 100 peer-reviewed articles and secured over $3 million in research funding. He currently serves as a scientific editor for applied ergonomics and has been a scientific convenor for Australasian Simulation Congress on four consecutive occasions. Great to have you with us, Anjum. Welcome.

**ANJUM NAWEED:** Thanks, Winona. And just following on from Sharon’s presentation, I think it’s going to be a very hard act to follow because it was so good. But I’ll do my best and hopefully give you a nice case study to think of in the context of the derailed environment.

So, this is where I work. This is my director, Professor Sally Ferguson, we’re down at the Appleton Institute, which is the Appleton based campus for Central Queensland University, which has a large national footprint as you can see on the right there. And we do lots of stuff in the area of behavioural science and in a very applied context.

These are the sorts of areas that I tend to do my work in. I’m very interested in performance and thinking and theoretical applications really to really-world problems. Most of my work does tend to be in the transport space, hence the reason why I’m focusing on rail and also why I’ve got a very familiar infographic style here to show my various areas. So, yeh it’s very much something that I focus a lot of my research on.

I work in the area of operational readiness. That’s the sort of theme that I’m performing my work in most. And this is an indication of the most at-risk occupations for mental health injury or injury susceptibility from Safe Work Australia. And you’ll see here that along with prison officers and welfare worker and so on we have bus drivers and rail drivers. Now bus drivers and rail drivers are also noteworthy as a body-stressing occupation and so, therefore, they’re at risk of work-based musculo skeletal disorders, and so that’s the reason I guess why there’s a full spectrum of focus that’s really needed in this particular cohort, and also one of the reasons why I really enjoy researching in this area too.

So just moving on there I want to talk to aa little bit about research that I’ve done in the area of light rail, that’s trams or streetcars. So anywhere where you’ve got trams, you’re familiar with the way these work. I’m sure most of you have ridden trams if not in Australia, then around the world. And, you know, the topic of musculo skeletal disorders in the context of driving these very large vehicles.

Just to give you a bit of an overview. I’ll be talking a little bit about MSD in this sort of context. I want to talk a bit to you about the characteristics of the task before jumping into the study that we did. Give you a bit of background on why we did that study and then also talk to you a bit about the mixed methods that were involved.

This is an acknowledge page for my co-authors. Most research doesn’t happen in isolation or with one person, so I want to acknowledge Lorelle, Josh and Carolyn for their involvement in this research. Carolyn now is working at Federation University and Josh is at Flinders University. Carolyn is also a professor, premium scientist in occupational therapy.

So, the background for this study, well, then, a travel organisation approached us, approached me, indicating that approximately 20 per cent of their driver cohort was on sick leave or on light duties, so they weren’t driving as much as they would ordinarily with work-related MSDs and that the cause that they’ve attributed themselves was to the design of the master controller. What that is, I’ll explain to you in a bit. And they were developing a business case to remove the current master controller and re-install a new proprietary design under the assumption it’s going to deal with some of these work-related musculo skeletal disorders.

And so, we embarked on a multi-method – sorry, mixed-method study in two different parts – well, two parts for the first study and one part for the second one, but it was conducted over time. And what we thought of all the way through this was the relevant subsistence thinking in prevention to try to understand the myriad of factors that might be causing these and whether, for example, replacement of a master controller is actually going to deal with it or not.

Before going into the meat of the work, I just want to give you a bit of background on what the human factor in light rail looks like. So, if you look at this slide, you’ll see sort of a flow diagram starting here with a tram and the driver and then going all the way around here and what the tram and the driver does, as you can see, is they drive according to what they can see outside the window and also the speed information that’s provided in the cab, what we call real-world target tracking. They then monitor the environment, and they use essentially proponents of situational awareness to establish the different stage and anticipate what they need to do for the future using a variety of external information to inform their throttle control. Then that dynamic control is also underpinned by the driver’s own knowledge base, understanding of the rules, standards of work, the route itself and how the tram works. And this sort of cycle continues.

So, what is a master controller? A master controller is the lever, guys would understand it, in the cab, the lever which propels the tram forward and back. So just to break that down, you can see a hand of the driver on there on the master controller. When you push the master controller down you activate a deadman device. Now that’s a totally euphemistic word for what this is – but that’s what it’s called. Essentially in order for the tram to know that you haven’t collapsed and that you’re operational, you’ve always got to keep this master controller depressed and it requires sustained force. And then that sustained force is also applied in the forward or in the backward direction. So, the backward to slow down, forward to speed up.

So you’ve always got to keep down a certain amount of pressure. The other thing is that this deadman – sorry, this master controller is interlinked with a vigilant system. So, as well as keeping it down all the time the system is designed to monitor whether the operator, the driver, has actually collapsed or not. It’s possible that they may have collapsed, and the weight is pushing it down. So, it checks after every sort of interval whether the driver is alert or not. And what you’ve got to do is you hear a sound going off in the cab and you’ve got to lift the master controller or do something in the cab to indicate that you are alert, you are still conscious by lifting it up and putting it back down again. Or you might be able to interact with something else in the cab, but the understanding really for us was that you would actually have to lift the master controller up or down. And so that may happen at intervals, we’re talking potentially 10 seconds, 40 seconds and so on. But, you know, the belief is that it’s a fixed interval.

You’re viewing images here of people in the tram itself. You can see pushing forward, pushing back at the top and then the bottom two images, pushing it down and lifting it up.

So, we approached this work by thinking about the kind of models that are out there. And this is a really big model that’s used in the context of occupational therapy by Christiansen and Baum. It’s called a person environment occupation participation model, or the PEOP for short. And if you look it, you’ll see there’s an emphasis on the person based on their intrinsic factors which delve into the applied cognitive areas but also bring in some of these bigger aspects – the spirituality and so on. On the right here you’ll see all the extrinsic environmental factors where you have culture and values, socioeconomic systems. And so, you can start to see, well, this model is actually appealing to systems-thinking view of complexity in the middle. You can see that these two things converge to actually apply constraints to the structure of the tasks and the actual act of doing the occupation and the performance.

This kind of model has been adapted and interpreted in many different ways, and so one example of this is by Kaskutas, the model of which it forms where you can see here that work performance and the environmental performance, work performance reached job demands in various different ways. It’s either insufficient or it’s out of balance. So, you’re not able to sort of reach basic competence or environmental performance, you can just have one or the other. But ideally, you’d want it to be sort of fitted completely. So, you’d have like an optimized match where the three things are working – work performance and job demands have been met appropriately.

So, our research design, we did two studies, as I mentioned. The first one was very sort of mixed methods in that we did observations and focus groups and interviews with drivers directly in a participatory way and then we did a large psychosocial survey to get more input from the other drivers inside that environment, noting that we probably could only, you know, get a fewer number of drivers to be involved in the first components. They were obviously driving with – you know, they were operating in a less than ideal context, some drivers that were off duty or on light duties, and so we didn’t want to place too much burden on them.

So, this is the first study, and I’ll start with interviews in the focus groups. So, the interviews and focus, obviously for those academics amongst you that are interested, it’s qualitative design. We did 10 one-to-one interviews with drivers, a mixture of injured and uninjured drivers to get a good representation across them. And we did one three-person focus group with all injured drivers hoping that it would be a scenario where they may feel more empowered to talk and share their thoughts as well as the one-on-one environment. They went for about 60 to 90 minutes and then we analysed it and deductively and thematically. So, we used the PEOP framework there as you can see to figure out where a lot of the themes were falling.

And I just want to give you some quick sort of indications of where everything fell. So, you can see some of the categories here – health management, attitudes, tension, all these sorts of things were found across the cohort. You can see the extent to which they were represented. And then we also had the environment, occupational performance.

I want to give you a bit of a slice of the person part for this one. So, if you look, for example, at prior physical status, the red books are the injured driver’s perspectives, and the yellow ones are the perspectives of the uninjured. You can see that the injured drivers felt that medical tended to be a bit problematic and that lots of people came into the job slipped through. People were economic with the truth about their own injuries and backgrounds. And then down here you can see in terms of tram driving there was a perception from both injured and uninjured drivers that there were problems. You could get aggravations from previous injuries if you’d had them. The job itself was sedentary and it wasn’t uncommon to feel pain associated with driving and use of the master controller after six months. We’re talking wrist, arm, upper limbs and so on.

Attitude towards injury, a great deal more going on here. Lots of beliefs from those that are uninjured around there’s nothing to the job physically, we don’t understand how injury could be happening, maybe it’s an issue for smaller frame people, a disbelief that those that are injured are actually now picking up extra shifts where the shifts are around and in reserve and they’re hanging around doing nothing and not pulling their weight. And there’s this perception that the incident of work-related musculo skeletal disorders, it’s bizarre that it could be happening in drivers with a large build or heavy frame. Surely, it’s just the medium build or light-build people that it happens to.

A lot of stigmatizing and silencing happening around perceived by the injured drivers. They thought that they weren’t able to speak up and so on. And this created this intergroup tension which led to a belief that the conditions not being accepted by other drivers and feeling invalidated, whereas the uninjured drivers felt that the accommodations they were making for the injured were imposing on the wellbeing and satisfaction for themselves.

Health management, you can see a mixture of different things that they did. The uninjured drivers tried to stave off any problems by doing a few proactive things. In terms of managing the health, immediately you could see that there was a variety of things. But there was also this kind of prevalent notion that they didn’t really want to say anything or do anything to the organisation in case it had any implications for their job. So, you can see that at an individual level it became quite a significant problem.

In the top right here, importantly, with the master controller perspective, the injured drivers believe the stem was too high, that the human body is not supposed to interact with a device in such a way. Continuous pressure was part of the problem. And then also this belief that the vigilant cycle was too short – about 10 seconds to 20 seconds. So, you know, the belief that after every 10 seconds the cycle is going to go off and so it requires too many activations from them, and they have to push it too regularly.

So that’s a bit of the information that we’ve got there on the interviews and the focus groups. Just looking at the in-cab observations, we followed a structured approach here as well. We didn’t just want to go and just watch what they were doing; we wanted to actually have like a systemic structured approach. So here we observed 11 drivers, six injured, five uninjured through their trips. So this was out and back from the depot. We did 526 minutes in total, just under 9 hours of footage from each camera, and we used a software called BORIS which essentially allows it to map a state or point events, and these are the events that we identified when we were going out. We were watching for whenever they were pressing the deadman and whenever they were engaging it in a backward position. All these behaviours which were point behaviours in the middle. The difference being the state behaviours are things that are happening with a defined space in time, and then point behaviours actually sort of happening just as they are. So, a marker that this activity happened. For example, there was a grip change. The state would be the duration of time from when they applied the deadman to when they ended it and so on.

More pictures here. You can see the cab at the bottom here, a variation in the way that the master controller is held, in different ways. Different grip positions. Top right here, movement to stretch, movement of legs, leg positions and so on. The one leg positions. And one of the issues we found was this peddle button at the bottom to record the traffic controller, right next to where you’d put your feet there was a lot of accidental depressions of that, as you can imagine, so the drivers had built kind of a habit of keeping their feet away from the footrest to avoid accidentally depressing it. Here you can see images of people reaching across the console, stretching and so on.

So, what we found here after doing some signals was the following: uninjured drivers were more likely to stretch their upper body than injured drivers. An average of 1.8 times over 15 minutes, whilst the injured drivers stretched less than once an average. Drivers with smaller builds stretched their upper bodies less than their counterparts with a medium build. And this one importantly – on average injured drivers engage in repeated vigilance behaviours twice as much as uninjured drivers. So, they activated it more than the others. Now what that means is that when the vigilance – there’s this belief or the vigilance device is going to go off at some point, and so to pre-empt that a lot of the drivers engage it before to interrupt that cycle. So that the alert never goes off, because the alert is perceived to be anxiety-inducing and punishing, actually, believe it or not. So, there was a lot of depressions happening. Those depressions happened more for the injured than they did for the uninjured.

Let’s have a look at this in a bit more detail. So based on the timed observations we found that the actual alert did not sound until 30 seconds, but the drivers that were injured as well as some of the others believed that it happened as early as 10 seconds. So, you can imagine that that device is going up and down quite a lot whilst you’re sustaining force. Now this modification occurred two years before the injury manifestation. It was changed for indiscriminate activation to an auto reset. So, what they did is they task linked it. So, every time that you moved it forward or back or you engage with anything else, it would reset anyway. But the belief was that if this was the original incarnation which just required a depression to go up and down. And so, you know, the injured drivers activated the vigilance device more than the uninjured and in line with the previous approach.

Now let’s have a look at the next study, the drivers survey. I’ll go through this very quickly. I won’t talk about all these, but essentially, we produced a psychosocial survey, required about 40 minutes to complete and 44 drivers completed the survey. There was a lot that didn’t want to complete it, but 44 did, and we had all these measures, these scales here, as you can see. And the analysis happened using conventional methods. I won’t go into what they are. We analysed for associations across them.

We found a bunch of interesting things. We found significant associations that those drivers are less aware of their body, are less limited in their workplace or feel less limited in their workplace, they’ve got a better work-life balance or when their emotional demands and task load are lower than their general wellbeing is more positive. This obviously goes without saying. It’s fairly straightforward.

But we found something really interesting in that higher perceived belonging support was associated with a lower chance of an injury being present. What that means is that the effect of work intensity on injured status was dependent on the perceived availability of interpersonal support.

So have a look at this graph here. So, work intensity in the context of tram driving is having to work at very high speeds or very tight windows. And you can see here at low and middle levels of perceived work intensity on the left the probability of injury increases with low levels of perceived interpersonal support. So, the less that you believe that you have interpersonal support, so support from colleagues, friends, those outside of work, the more – the higher the chance, the higher the probability that you’ll actually experience a work-related musculo skeletal disorder or an injury.

So you can sort of see here this complex picture coming together. So, let’s have a look at the bigger picture. Prevalence of the upper body stretches amongst uninjured drivers. There’s a misunderstanding amongst drivers concerning the time lapse for the activation of the vigilance system. The amount of the time the driver spends using forward or backward pressure on the master controller in conjunction with downward force in order to keep the deadman system engaged was not associated with a difference in the prevalence of injury. There was an unnecessarily high activation of the vigilance system amongst injured drivers which was a legacy behaviour and could be considered injury priming. And when drivers perceived that work intensity was high it was the drivers with lower levels of interpersonal support that were more likely to be injured.

What that made us conclude was that the master controller may be a contributing factor, but it alone is not responsible for injuries amongst the drivers. So, let’s have a look at the system in a bit more detail. On the left here you start off with the vehicle which has the deadman, the vigilance device, the cabin interface, vibration demands, of course, from moving traction in that kind of environment. Then you have the driver and their fundamentally limited in these ways. They have to use their attention, they’re easily distracted, and they’ve got to be quick with their reactions as you’ve seen with the vigilance device. It’s a sedentary job and requires considerations around fatigue and shiftwork.

They’re operating in an environment where they’ve got to move a certain way. And also, a rail infrastructure which is quite technically designed in certain ways and also requires management and maintenance in certain ways, too. And that includes the assets, the vehicles themselves, like the master controller device.

And then you’ve got the service delivery demands with all that while they’re running to a timetable, schedule which can move at different sort of speeds and pressures. Around all that you’ve got a mixed traffic environment that behaves very differently in an open way so people can access it. It looks different in day than it does at night, in peak and off speak and so on. Weather also affects the drivability of that tram.

But behind all this then you have all these constraints that are placed on the psychosocial influences that manifest. So, with all this the drivers have own goals, they’re motivated a certain way, they feel pressures, they behave to their own social norms and within the presiding organisational culture, but, of course, all these things collude to create these health impacts which can be very mental in the context of stress and anxiety but also a variety of physical ones – cardio metabolic and, of course, the topic of this conference – musculo skeletal disorders.

Now if you look at our results, which was done in a mixed methods way, something in all these layers is implicated. So, it’s not just simply a case of saying it’s just the vehicle or one thing on the left-hand side. You can actually see that there’s a myriad of colluding factors across all these that behave to actually impose these sorts of issues on the individuals. Now predispositions come into this, predispositions of anxiety, predispositions for behaving a certain way come into it, of course. But without adequate support for all these things, in some ways the musculo skeletal injury or disorder is probably not avoidable.

So, we then got all that information and adapted it ourselves and updated it into a new version of the PEOP model just in the context of musculo skeletal disorders for tram driving and light rail. And you can see here we put everything in. You’ve got vigilance manifests in various ways, on the person side, on the organisational side, and the performance side here. As well as all the other things like the intergroup tensions, like the presiding organisational culture where a lot of that interpersonal support is important and needs to be found. And in its absence, you’ve actually got some issues, haven’t you?

We have published this work in Safety Science, which is Sharon’s journal, and if you want more information, please go and download this one. It’s an open access article. More information about the project. And if you need to contact me, my details are on the left there. I have a social media presence as well you can email me directly. Thank you very much for your attention.

**MADONNA KING:** And thank you for that pension. So much detail. I learned so much, Anjum. Thank you. Plenty of questions coming in, and you can log yours in the live Q&A chat on your screen as well. Let’s start with Peter. He says if the downward force exertions on the master controller are acceptable, would it be reasonably practicable to accommodate those limiting users such as shorter stature operators with elevated arm support?

**ANJUM NAWEED:** It did have elevated arm support and things like that in there. But I would just question whether that’s a bandaid solution and whether something bigger needs to happen as far as the design of the master controller is concerned.

**MADONNA KING:** That leads very well into our second question: if you were actually designing a cabin today, what would be the process? Can you walk us through the first steps you would take?

**ANJUM NAWEED:** I don’t think I’ve got all the time to answer that kind of question. Look, if you were designing something from the beginning then it wouldn’t be just me designing; it would be a large group of people, very interdisciplinary, looking at specifications and building in some really good risk management processes and recognising the anthropometric profiles of those people that would be in the cabin.

**MADONNA KING:** So, can I just stop you there. What kind of people? Give us a guide?

**ANJUM NAWEED:** Well, I don’t really want to say that you need people with a certain build, or you need people with certain affinities psychologically. I think that any kind of job would be suitable for you, but I think that in the case of this particular one you’ve got to recognise that the organisation did not tell the drivers that the vigilance became task linked. And so, the injuries started not long after. So, in that context you can assume that perhaps the static strength load requirements and the master controller were okay, but these problems developed afterwards, so that kind of started beyond the fact. So, I think that it’s important to recognise who you’re recruiting as far as the predispositions go. We found a lot of these elements associated with anxiety that were injury predisposing. But there’s nothing to say that the job didn’t actually make them anxious when they came into it. How do you produce a job that maintains that good mental and physical balance, if you will?

**MADONNA KING:** Absolutely. How did you motivate drivers to complete the survey?

**ANJUM NAWEED:** It was difficult, Madonna. It was very difficult. We had drivers that took part in the first phase, as you saw. In the second phase, because it required a lot of work and there was organisational support to do it on organisational time, it was voluntary. I think we had roughly probably about a third or a half of the drivers completed it in the end. So statistical power was a bit of an issue for us. What we really needed was as many drivers as possible. But in the end, it wasn’t that we were incentivizing them through money or anything like that; it was this is a really important issue, and we need to understand it and we’re just one other organisation after many that have come and spoken to you. Please know that we’re doing something a bit different here and we wanted to understand more about what’s going on. And through that kind of narrative and discourse we managed to get drivers involved.

**MADONNA KING:** This is a great follow-up question: Thank you, did this research shift the perceptions of drivers about their own risks?

**ANJUM NAWEED:** I would like to believe that it did. It was all very transparent, and it all came out to the whole organisation and to the drivers. We were quite open about calling out the cultural elements that were in some ways reinforcing a lot of these problems. Like if you’re not feeling you’re getting support, you’re not feeling validated, we found an association, in interaction terms. It was really fascinating how just knowing that you are believed, or you’re validated by your peers and your colleagues might actually reduce your chances of an injury, or at least dampen its effects. So, it ended up being this unusual cycle.

We wanted to share that and show that they were all aware of that. And we hope that was taken on board.

**MADONNA KING:** A question from Lani: You’re talking about interpersonal support. What types of interpersonal support? Was it from co-workers, managers or employers?

**ANJUM NAWEED:** Well, it was, “Are you okay?” Sitting down talking, wanting to be heard, not feeling like you were being judged. “How are things going on?” That connectivity that happens. In the end what we saw was instead of that happening there was more sort of enclaves that were developing in the room – separate groups. And you can sort of see there that disconnection was creating lack of support. So, it was more the interpersonal, “How are you going,” looking after them by asking about your wellbeing.

**MADONNA KING:** So important, isn’t it? Anjum, you know our theme for the conference is Safety by Design. If I asked you what that means, what your perspective on that is, how would you answer it?

**ANJUM NAWEED:** Well, if people are going to be assigning blame to an artefact in the cab in the context of a master controller and assuming by changing it by putting in another one is not going to adversely impact the 80 per cent of drivers that aren’t affected and cause new problems, then I would say that a radical rethink is really required of the way that the tram vigilance system and also the deadman system works and recognising that these are legacy systems and we need to think about how we can adapt them to fit with the driver in a more integrated way than they are currently.

**MADONNA KING:** Thank you so much for the honesty of your answers, but also the detail of your presentation, Anjum. Thank you.

**ANJUM NAWEED:** No worries. Thank you.

– ENDS –