Peter Klauser – Wrap up Day 1 (Aug. 2, 2016)

I hope you will all agree that we had 10 very high quality presentations. I thank the presenters for their contributions, and the organizers for organizing the program.

From these presentations I have taken away 2 primary ideas, 2 specific topics and a vision for the future.

My primary ideas are the 2 M's: modelling and measurement:

1. *Modelling: While a great deal of work has been done in the modelling area, I think there is a great deal that still needs to be done. Why does RCF form in specific locations, why do cracks develop in some locations and not develop in other locations? Why do some cracks develop and run parallel to the rail surface, while others turn downward? Why do some small cracks eventually develop into large cracks? Why do some of those large cracks lead to rapid rail failure, while other large cracks exist for long periods of time?*

   In some rail failures you will see large defects that are rusted - they've been there for a long time. Why do they eventually result in failure? So another area of modelling is fracture mechanics. What is the combination of conditions that cause that rail to suddenly fail? Was it temperature, was it rail wear? All of these are issues surrounding the question of how to predict the benefit of what we want to do (change rail profiles, lubricate, and other corrective approaches)?

   We need a method to understand the benefit, and how those measures will improve our situation. So there's a vast array of modelling still to develop. That's on the RCF side, and then we have wear. How do wear and RCF interact? Wear is a removal of material, but we also have negative wear. We have plastic flow, where in locations the contour grows. So we need also to be able to predict plastic flow.

   An issue that wasn't covered, although Mike Roney did give us some numbers, is dollars and cents. Costs and benefits are behind all of the technical decisions that we make. We ultimately have to sell those decisions, so economic modelling is very important. And I don't think we know enough about that issue. How much does it cost, is there a benefit? Is there an economic benefit to grinding out deep defects just to get another 1/16" of rail life? We need to be able to develop the numbers, so that we can sell those technical innovations or decisions.

2. *Measurement. All of these models will rely on measurements. We need to be able to calibrate the model and/or verify its predictive capability, so we need to be able to measure relevant things. And we talked about our two options;*

   a. *We have the operating full-scale railway, which by definition is realistic, is tapping into the real world, but it's an uncontrolled experiment. We heard today about a great deal of data being collected. It's often proprietary so we can't easily access it, but it would be valuable to be able to mine that data. We make lots of RCF measurements, sometimes over an entire system. Are there lessons to be learned from looking? Why does RCF*

occur here in certain curves but does not occur in all curves that have similar characteristics? Can we make use of that data?

b. *Then we have laboratory testing, which in many cases we admit is not realistic. But it's controllable, or at least we hope that it's controllable. And there seems to be a move, if we have the money available, to create full scale laboratories, which might address the lack of similarity between the small-scale laboratory test and the operating railroad but still provides us with a controlled environment.*

I'd like to offer some specific research ideas:

- *What can we do to develop techniques to modify and investigate cracks? What's inside a crack, how can we measure crack face friction? These in turn support the modelling issue.*
- *This issue of interruptions: if we interrupt lubrication, what is the effect? If we miss a grinding cycle, or we delay a grinding cycle then what's the effect? Have we created a system requiring a well-defined set of steps that must be maintained to reap the benefit of excellent or high quality rails? That if we miss these steps then we create a more catastrophic situation than we had before?*

Lastly my vision, I was very impressed by a presentation that Dan Hampton made about efforts at CSX and the research going into their grinding train. I have this vision of an autonomous grinder that detects cracks, finds them, and grinds them away. It's going to be a bit like this robotic vacuum cleaner in the U.S. called a Roomba. You set it loose in your living room and it just vacuums away. Your dog chases after it because it's this annoying thing that bounces off of your furniture, but it's out there finding dirt and vacuuming it up. So we'll have a grinder that will roam the system, finding cracks and removing cracks.

In Dan's slides we saw that the CSX slogan is "how tomorrow moves'. But I can envision the day when the new slogan is "No RCF anywhere, ever".