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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HUM INDUSTRIAL TECHNOLOGY, INC.

Petitioner

v.

AMSTED RAIL COMPANY, INC.

Patent Owner

Case IPR2023-00538

Patent No. 9,365,223

EXHIBIT 2013

DECLARATION OF ANDREW MARTIN

AMSTED 2160
IPR2023-00538

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1. I, Andrew Martin, declare as follows.

I. INTRODUCTION AND QUALIFICATIONS

2. I was an employee of IONX LLC and then Amsted Digital Solutions (“Amsted”) from about 2005 to 2022. My final title was Senior Director of Fleet Management. I have a B.S. degree in Mechanical Engineering and an M.S. degree in Industrial Engineering from the University of Pittsburgh. I have been working as an engineer for over 20 years and in the rail industry specifically for more than 18 years. I have been listed as a co-author on numerous published papers and as a co-inventor on numerous patents and patent publications. Appendix A is a recent C.V. detailing my experience and accomplishments in the field of engineering.

3. I am listed as an inventor on a number of Amsted patents, including 9,365,223 (the ’223 patent) (Ex. 1001).

4. I have been retained as a consultant on behalf of Amsted in connection with that lawsuit and the present IPR Petitions. However, I have no ongoing involvement with Amsted and I have no financial interest in the outcome of the litigation.

5. I have reviewed a number of records which are cited in this declaration and are included with it as exhibits.

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6. Throughout my time at Amsted, I was personally active in, among other things, product conception research and development of new railcar monitoring technologies. I was actively involved in numerous condition and health monitoring initiatives throughout the period discussed in this declaration.

Conception of the IONX/Amsted Bearing Condition Monitoring System

7. Train bearing temperatures had been generally measured wayside when trains passed by a facility with the capability of performing wayside measurements of the temperature of the bearings. One issue with this method of measuring bearing temperatures is that it does not allow for bearing temperatures to be measured between wayside checks. This method is therefore limited in its ability to detect bearing issues early on and help to avoid or prevent failures.

8. Our project was to design a system that would enable bearing temperatures to be continuously (or near continuously) monitored onboard trains. By measuring bearing temperatures onboard trains, rather than at stations capable of measuring bearing temperatures, early detection of bearing issues would be possible, helping to prevent bearing failures. Additionally, train routes often place trains long distances away from services teams. In the event of a bearing failure, if the train were a long distance from a service team, the time and costs associated with repairing the train would be increased. By detecting bearing issues early, one goal of this project was to be able to analyze bearing issues to enable trains with

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bearing issues to function at a reduced rate to effectively limp along to areas where service teams were present.

9. Initially, we planned on using existing Smart Pad technology to supply the sensor units for the contemplated monitoring system. It became clear as development continued that the use of instrumented pads would not work because the mechanical interface was not stable enough to support the electronics and not durable enough to live up to the railroad environmental requirements. Initial tests of alternative mote designs showed mixed results to measurement reliability were and solutions underway in the 2008 and 2009 timeframe. The data gained from these studies was directly impacting algorithm and heuristics development for eventual evaluation, validation, and testing during an upcoming field test with SCT Logistics in Australia using the alternative mote technology. Comprehensive bearing temperature algorithm research, validation, and testing were conducted by a research group at the University of Texas-Pan American ("UTPA") (now called University of Texas-Rio Grande Valley). This included testing and validation of Amsted hardware as well as the teardown and analysis of train hardware in which actual or potential faults were detected. UTPA supported the work between Amsted Rail Company and SCT Logistics, leading to the commencement of an in-service trial to monitor wagon bearing temperatures. The primary role of the trial was to set up laboratory tests, process data, and present results. When we supplied

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UTPA with raw data from the field, they would process the raw data and provide results.

10. By May 2009, after some development, the new temperature motes, which we referred to as wireless sensor nodes (WSNs) were not behaving as expected, requiring some redesign. Around September 2009, manufacturing issues arose concerning soldering of the boards in the WSNs and a new set of motes for the SCT Logistics test were made.

11. On December 3, 2009, I authored assembly instructions detailing how to assemble the inside of a temperature sensing device (mote), including how to attach the wires onto the pins of a temperature sensor, which in turn contacts a brass plug for thermal communication and is also connected to an electrical circuit board and soldered to an internal power source (battery) and a printed circuit board that included processing and communication circuitry, thus enabling the device to communicate information regarding the temperature. Exhibit 2092 is a copy of these assembly instructions.

12. On December 9, 2009, Brent Wilson emailed Jeevan Robinson photos of the mounting for the temperature sensing devices. I was CC'd on this email. Exhibit 2136 is a copy of this email.

13. On December 17, 2009, I received an email from Glenn Baker attaching a "SCT Hit List" that detailed the tasks related to the SCT trial and

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reported on their status. Included on this task list as #23 titled WSN 102 problems discussing reliability issues with pre-production WSN 102 motes. On going task #2 noted that work on WSNs was on hold pending engineering rework. Also included in the list were various tasks related to algorithm development (#15), internal documentation explaining the methodology of the temperature measurement (#30), and schedule development including pending WSN issues (#33). Exhibit 2149 is a copy of this email and task list.

14. On December 21, 2009, Matthew Lehmer emailed William LeFebvre, Glenn Baker, Brent Wilson, and Jay Monaco an updated test plan for the first three months of operation of the SCT Logistics Australia field test that included a description of the test equipment, installation/operation instructions and strategy, and output expectations. I and Mike Gaynor were CC'd on this email. Exhibit 2162 is a copy of this email. This test plan indicates that the inventive system includes a plurality of the temperature sensing devices that are installed on a plurality of railcars that collect data at periodic intervals and communicate with wireless communication management units (CMU's), wherein the CMU's also receive data from an external (ambient) temperature sensor.

15. By January 2010, the team had been getting set up for the upcoming SCT field trial, as indicated in several emails between myself and my team discussing the shipment of motes and adapters and how they attach to each other.

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These email discussions included a January 6, 2010 email discussion with Matt Lehmer and Tom Petrunich, and a January 21, 2010 email discussions with Matt Lehmer and Tom Petrunich. Exhibit 2163 is a copy of the January 6, 2010 email discussion. Exhibit 2167 is a copy of the January 21, 2010 email discussion.

16. On January 15, 2010, Matt Lehmer sent an email to me, Steve Kreckman, and Susan Kefer, detailing his completed “RF Survey” using an Amsted boxcar and a sensor system for SCT. Attached to the email was the RF Survey. CC’d to the email were William LeFebvre, Brent Wilson, and Glenn Baker. Exhibit 2164 is a copy of this email.

17. On February 18, 2010, Doug Cummings sent an email to me, Brent Wilson, and Matthew Lehmer. CC’d to the email was William LeFebvre. In the email, Doug Cummings discussed the implementation of a timetable for SCT installations. Exhibit 2166 is a copy of this email.

18. In March 2010, I produced a presentation describing a condition monitoring system we envisioned that combined the new WSNs with our Series 3 communication management units (CMUs) in a mesh network. The WSNs used wake/sleep power management such that they would typically be off and not using power most of the time. Exhibit 2017 is a copy of that presentation. Exhibit 2018 is the metadata from that document showing I was the last person to modify the presentation on March 21, 2010. By late March 2010, initial installations were

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underway for testing with SCT Logistics. These initial installations were documented in Exhibit 2016. which is a copy of an email sent on March 24, 2010 by Brent Wilson to William LeFebvre, Jay Monaco, Matthew Lehmer, Doug Cummings, and myself. The attached pictures show the notes attached to the bearing adapter sidewalls of the respective train cars that were augmented with our equipment.

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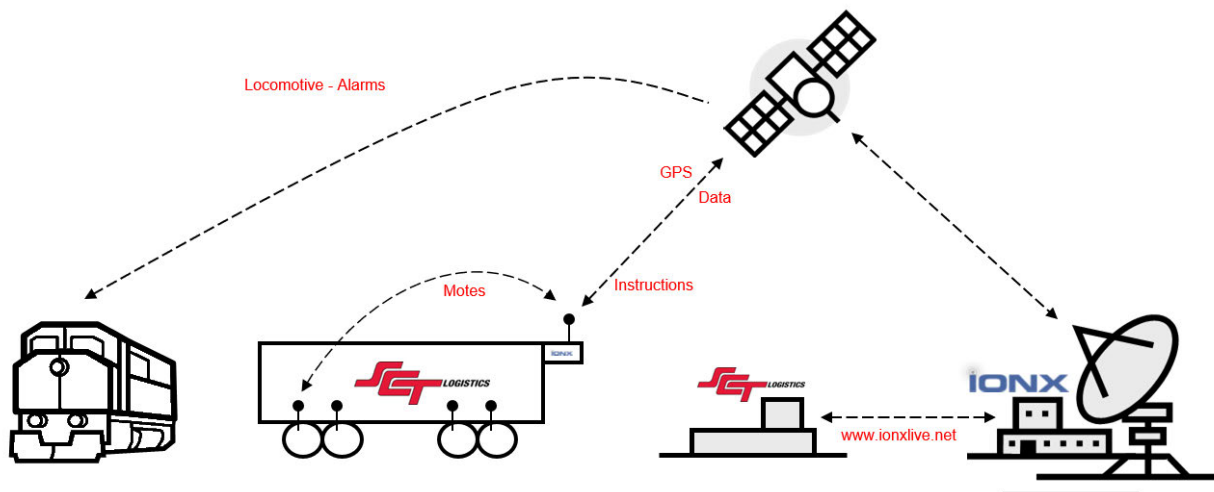


Typical and Modified Installations

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19. In response to a phone conversation with Ron Bury of SCT Logistics, Brent Wilson and I conceived of a revised alarm notification system. It was communicated to Mr. Bury in an email sent by Brent Wilson on March 31, 2010. I received a copy of it on that date. Exhibit 2019 is a copy of this email and attachment. Attached to this email is a one page Word document that describes revised alarm stages that limit alerts sent to a locomotive terminal until actionable events occur. This document was written by Brent Wilson and myself. On the same day, I informed my team at IONX of these changes and included instructions for programming the tiered alerts based on the severity levels Brent and I had discussed with Ron Bury. Exhibit 2058 is a copy of this email, which I sent from Brent Wilson's email account.

20. The Amsted team, including myself, conceived of the inventions of the '223 Patent by April 4, 2010. By this date, we had completed a presentation, titled "Railway Freight Wagon Bearing Monitoring Locomotive Alarms," and I sent this presentation to Ron Bury of SCT Logistics in response an email request. Exhibit 2020 is a copy of the email attaching this presentation that I sent to Ron Bury. Exhibit 2021 is a copy of Ron Bury's email I received the day before. Conception of the IONX/Amsted bearing condition monitoring system is further reflected by this presentation. This presentation included descriptions and drawings and/or pictures of an overview of the system,

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of bearing adapter sensors,

4 bolt attached sensor (for smaller bearing end caps)

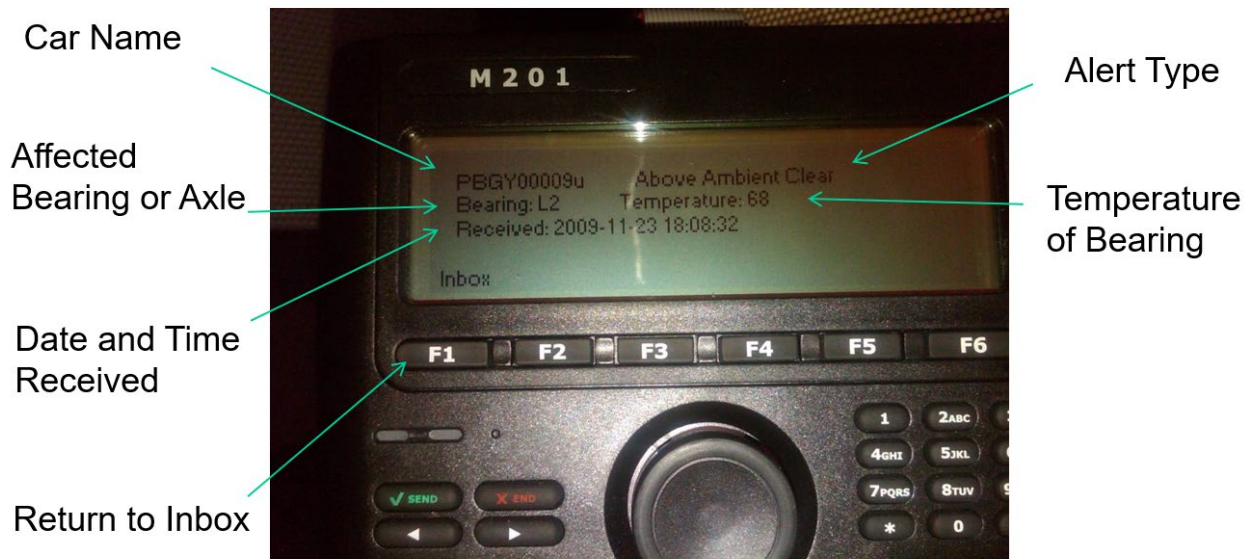
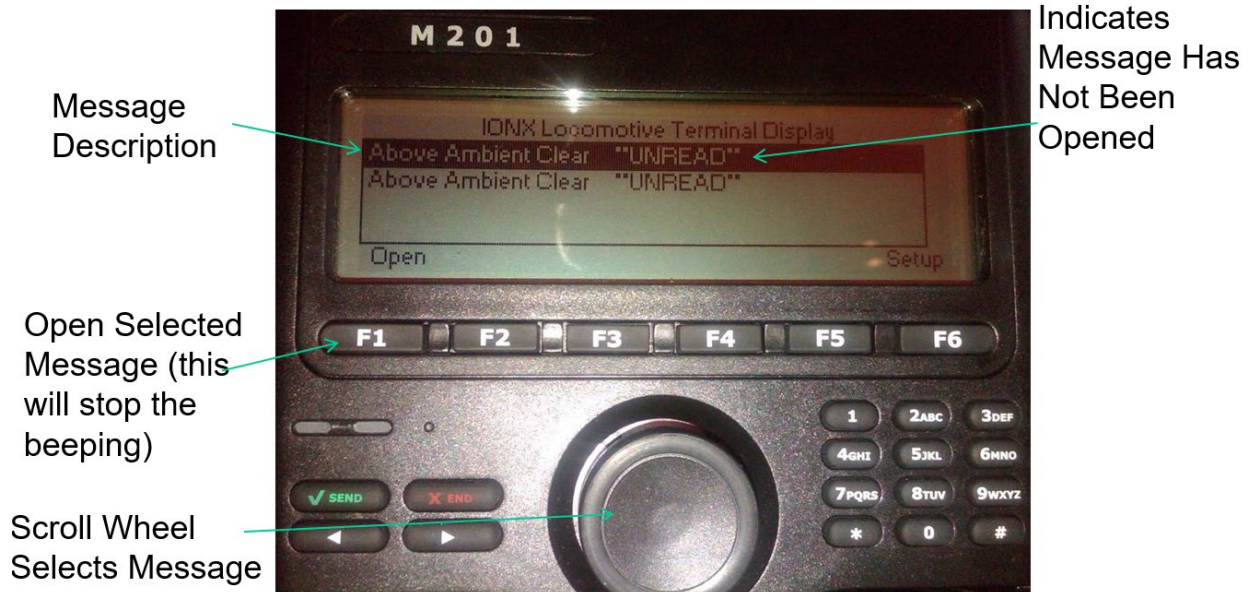


2 bolt attached sensor (for larger bearing end caps)



and of a cab display indicating messages, whether a message has been opened, an ability to open a message, a car name, an alert type, an affected bearing or axle, a date and time receive of the alert type, and a temperature of the bearing.

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The presentation also described alert instructions, including four alert stages described as:

Stage 1: Bearing Trending

- Alarm to IONX only.
- Will be removed from locomotive display terminals
- Will be used for trending recommendations and repeat offender identifications

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Stage 2: “Axle Differential Alarm”

- Action: Stop train, check journal of alarmed bearing. Look for signs the bearing is “walking off” the axle or grease is being purged.
- Proceed at reduced speed of 60 kph maximum until stage 2 alarm clear message is received at locomotive terminal
- If stage 2 alarm clear message is received at the locomotive terminal, proceed as normal

Stage 3: “Above Ambient Alarm”

- Action: Stop train, check journal of alarming bearing. Look for signs the bearing is “walking off” the axle or grease is being purged
- Proceed at reduced speed of 30 kph maximum until stage 3 alarm clear message is received at the locomotive terminal at which point speed can be increased to 60 kph.
- If the alarm message does not clear, a choice can be made to remove and change the bearing at an appropriate stoppage point, otherwise reduced speeds are required to reduce the chance of a screwed journal.
- If Stage 2 and Stage 3 alarm clear messages are both received at the locomotive terminal, proceed as normal

Stage 4: “Bearing Temp Alarm”

- Action: Stop train, remove bearing.

Testing of the IONX/Amsted Bearing Condition Monitoring System

21. Between April 2010 and August 2011, research, development, and testing into the inventions progressed and was generally continuous. During this time period, I was continuously working on this project, making improvements to the design and functionality of the system nearly every work day. Nearly all of my working time during this time period was spent working on aspects of this project.

22. On April 2010, different temperature levels for the different alarm stages were discussed. In particular, on April 6, 2010, Brent Wilson described, in

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an email sent to me, Doug Cummings, William Lefebvre, Jay Monaco, and Cameron Beange, his ideas on the different stage temperatures in an email which was also sent to Ron Bury of SCT Logistics. Exhibit 2023 is a copy of this email. In this email, Brent Wilson stated, in part:

[REDACTED]

[REDACTED]

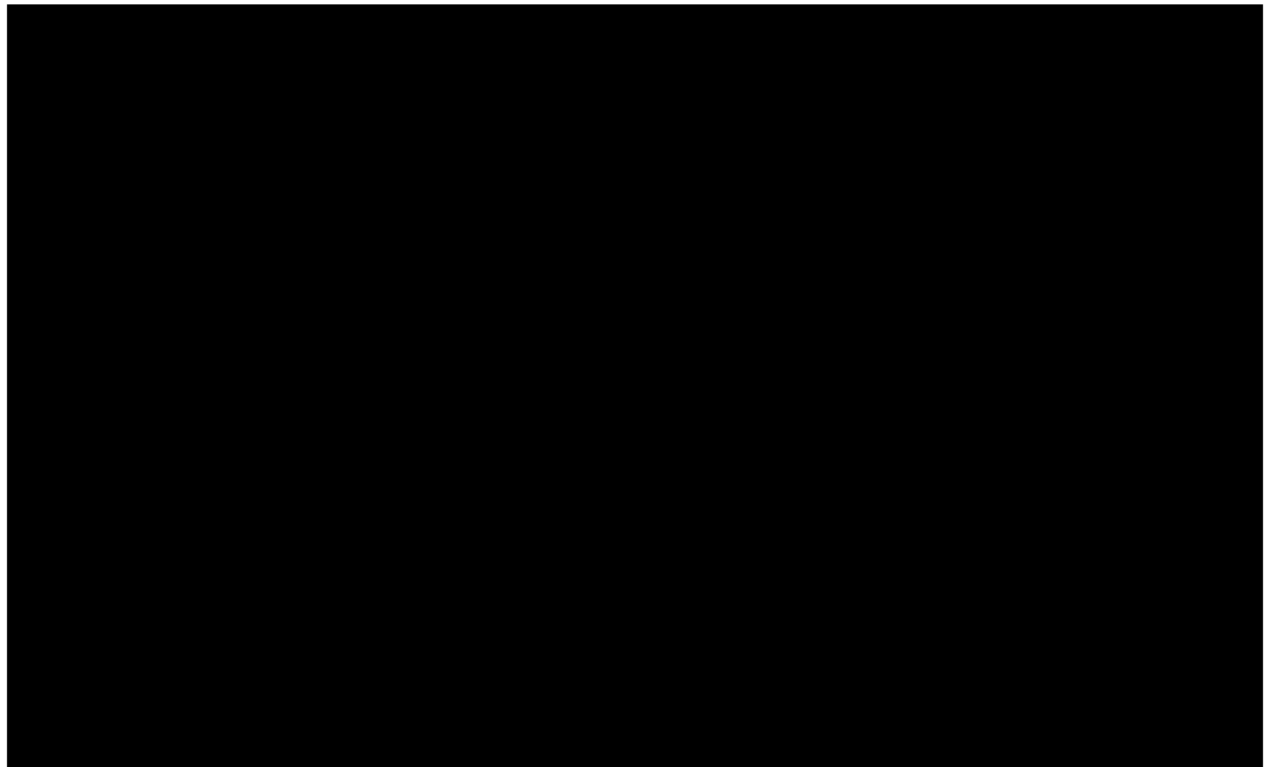
[REDACTED]

23. Brent Wilson and I had additional discussions that month regarding the algorithm instructions regarding certain temperature thresholds in order to fix frequent alarm levels that we had been experiencing. The temperature thresholds that we were using during this project was roughly the same as industry standard thresholds used for analyzing train bearings. Exhibits 2024 and 2025 are copies of these email communications.

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24. Work and analysis on the temperature thresholds continued throughout the research and development of this project. On April 6 and 7, 2010 Matthew Lehmer, Brent Wilson, and myself provided photographs of the installations to William Lefebvre who prepared a PowerPoint presentation detailing the status of the project. Exhibits 2026, 2027, and 2028 are copies of those emails. On April 8, 2010, William Lefebvre informed Amsted management about the SCT Logistics installation and included the presentation. Exhibit 2022 is a copy of an email communicating this presentation on “Bearing Monitoring & Locomotive Alarm System” to others around IONX and Amsted. The presentation shows, at slide 10, various detected temperatures and associated actions.

Alert Instructions



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25. We performed research and development such that we were working to be able to determine, during a stage 1 alarm, whether the alarm was due to an error or, if not due to an error, how far a train car could travel until an estimated bearing failure.

26. By April 2010, the field trials of the bearing temperature motes with SCT Logistics (Australia) had started. These bearing temperatures were monitored and analyzed to make the bearing temperature algorithms more robust. Continued work on temperature analysis, as it pertains to the sensors, was also performed during this time. Additionally, in April 2010, the team began work on a procedure for the configuration of temperature settings, enabling us to update thresholds on all nodes of all units to calibrate the sensors. Exhibits 2031, 2032, 2033, and 2056 are copies of emails reflecting this work.

27. On April 7, 2010, Brent Wilson sent an email to the research group at UTPA to inform them that a bearing that was pulled from service soon after the trial started would be sent to them for analysis. While I did not receive this email, I was aware that this analysis would be conducted. I contacted the research group at UTPA to discuss new analysis we would need to validate the operation of the system. Exhibit 2034 is a copy of my email to the UTPA research group regarding this new analysis. This group provided research assistance at Amsted's direction during the development of the WSNs by, among other things, studying the

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calibration calculations required to infer the temperature of the bearing from the temperature measured at the bearing adapter. These studies informed the work done by the Amsted team described above in reference to Exhibits 2031, 2032, 2033, and 2056. My emails with the UTPA group are shown in the earlier emails in the chain reproduced in Exhibit 2034 as well as Exhibit 2055. By the end of April, I had scheduled a trip to UTPA to discuss the SCT Logistics analysis project and to give them my project plan. Exhibit 2057 is a copy of an email I sent to the group at UTPA confirming this trip. Throughout the period of this declaration, I met with the group at UTPA almost every week. Brent Wilson also attended some of these meetings. We sent them up with access to our dashboard for the SCT Logistics project and UTPA staff download data from our field equipment in Australia on a weekly or bi-weekly basis and conducted analysis at our direction. They would inform us of any bad data or data that otherwise did not meet expectations. They would analyze the data using our algorithms and would flag bearings that tripped the various thresholds we gave them. Brent Wilson was primarily responsible for the initial development of the algorithm, but as the project progressed, I was primarily responsible for any improvements based on the data analysis performed at UTPA. The analysis and results that UTPA would present to me in our meetings would give me action items to pursue at Amsted. We would review any data showing a flagged bearing and use the information to validate or modify our

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algorithms. This continued on a roughly weekly bases for the entire period. In the paragraphs below, I discuss these meetings and results month-by-month.

28. By May 2010, the progress of our program in Australia was being well-received and generally successful to this point. A meeting with the group at UTPA occurred on May 4, 2010. Exhibit 2059 is a copy of an email attaching my trip report to my team at Amsted and the group at UTPA. I included in the trip report a detailed description of the conclusions and next steps. During this meeting I provided UTPA with detailed instructions regarding the analysis and the deliverables we needed from them. Among the projects discussed were improvements to the WSN calibration curves that relate the temperature of the bearing to the temperature sensed by the WSN and the analysis of data received from SCT during the trial in Australia. Exhibit 2060 is a copy of an email I sent to the group at UTPA on May 4, 2010 attaching the test plan, which included my instructions for the analysis and deliverables. I followed up with UTPA in the following weeks and added additional requests by email on May 17, 2010. Exhibit 2061 is a copy of this email. Work continued throughout the rest of the month to resolve these issues. Exhibits 2062, 2063, 2064, and 2065 are copies of emails demonstrating this work.

29. On May 18, 2010, I emailed Ron Bury at SCT logistics regarding a solution to an issue raised in April regarding unwanted bearing alert messages.

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Exhibit 2039 is a copy of this email. On May 25, 2010, I had advised the SCT that the IONX engineers were “not yet ready to send test messages to locomotives at SCT.” Work progressed and, on May 28, 2010, I was able to advise the team that the IONX engineers were “about ready now to send test messages to two locomotives at SCT.” Our testing continued and, on June 1, 2010, I emailed R. Jenke, R. Bury, and A. Hender to update them that the testing “went very successfully” and that the “result is that tomorrow all the locomotives will be properly configured so that they no longer receive ‘Bearing Temp Clear’ messages without first receiving an important ‘Temp Alert’ message.” Exhibit 2044 is a copy of this email communication chain. The “Bearing Temp Clear” messages were errors in the system that we were working to eliminate.

30. Our research and development was continuing and going well at this time for the SCT Logistics program and our data was being used to refine the algorithms. Testing continued at UTPA and the preliminary results were provided to me on June 1. Exhibit 2043 is a copy of the email I received from Andoni Zagouris, forwarded to Brent Wilson by Constantine Tarawneh. As indicated in Exhibit 2043, our expectation was that we would receive weekly updates on the analysis being conducted at UTPA at Amsted’s direction on the SCT data. We also were expecting results on a separate analysis of WSNs operation at high temperatures to calibrate our algorithms for higher level severity levels. On June

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11, 2010 Constantine Tarawneh provided Brent Wilson with a preliminary report regarding UTPA's tear down of the bearing pulled from service during the first week of the trial. Staff at UTPA sent us the calibration curve a few days later. Exhibits 2046 and 2066 are copies of these emails.

31. In June 2010 we began to have regular conference calls with UTPA. In a conference call on June 22 where we were shown the initial results of UTPA's analysis of the SCT data using the IONX bearing health monitoring algorithm. Javier Kypuros sent us the presentation slides prior to the call. Exhibit 2067 is a copy of the email I received with the presentation slides attached. The algorithm had identified three bearings of concern. On June 25 we had a follow up call with the UTPA group on updated results regarding the three bearings identified previously. Exhibit 2068 is a copy of the email from Javier Kypuros attaching the presentation slides for the June 25 call. We received several other follow up emails with updated data on these bearings through the end of June. Exhibits 2069, 2070, and 2071 are copies of these emails.

32. In July 2010, we continued monitoring bearings with IONX in Australia. This enabled us to continue to observe bearing behavior, including the apparent directional dependence of bearing temperatures on certain cars. This directional dependence included temperatures at or below an average of a carset in one direction, and temperatures that were significantly increased on a return trip.

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Our continued research and development included analyzing behaviors such as this in order to try to determine the cause for such observations, especially since the causes of these and other observations could affect the algorithms which were also being worked on at this time.

33. Exhibit 2049 is a copy of an email from Brent Wilson to employees of Amsted Rail, in which I was CC'd, discussing this directional dependence observation.

34. On July 6, following a conference call with UTPA, I sent to the research group there an updated set of instructions for the data analysis we required on the SCT data. Exhibit 2072 is a copy of this email, referencing two PowerPoint slide decks sent to me by Javier Kypuros on June 22 and June 25 respectively, which I discussed above in reference to Exhibits 2067 and 2068. Following more meetings with UTPA, I sent on July 13 additional tasks and instructions regarding the data analysis UTPA would perform. Exhibit 2073 is a copy of this email, attaching a document detailing IONX bearing condition algorithm instructions. UTPA sent a new calibration curve on July 14. Exhibit 2074 is a copy of this email. Another meeting occurred on July 29. Exhibit 2051 is a copy of the meeting invite for July 29 including updated task list items.

35. On July 19 2010, I prepared a report for SCT Logistics titled "SCT LOGISTICS BEARING CONDITION MONITORING TEST TEST REPORT."

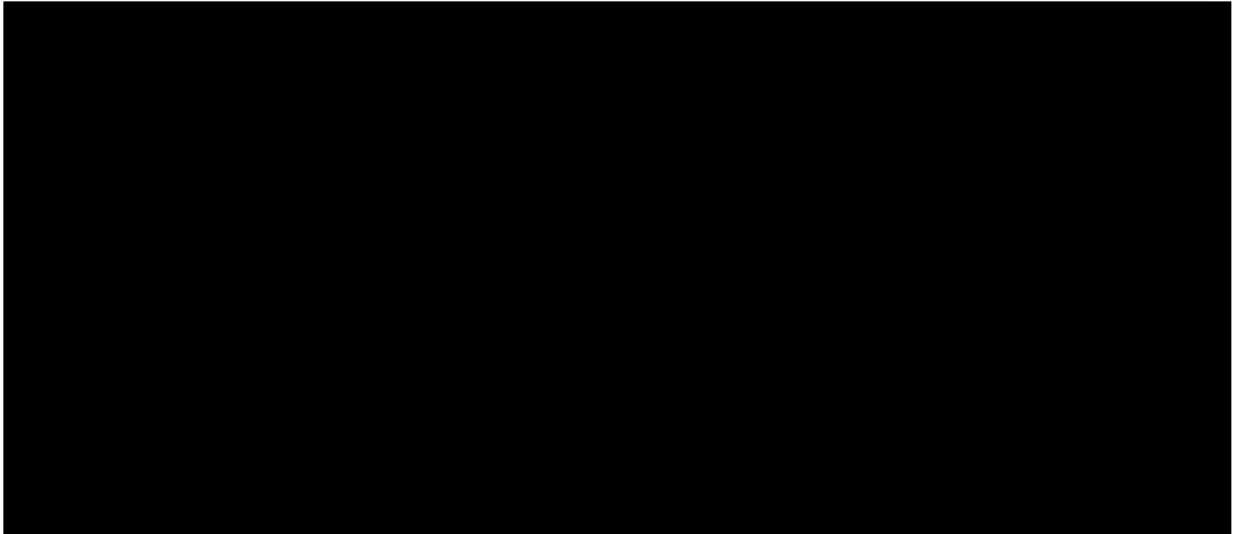
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The report listed present information on the bearing testing. In part, this report listed progress that the team had made pertaining to the field tests, and described improvements and development that was still needed and how continued research would be done to continue this research. For example, the report stated the following:

7.2 IMPROVED PREDICTIVE ALGORITHMS

Work is already well under way for improving the current predictive maintenance algorithms. The next stage of development will be in Gradient analysis which is outlined below.

Stage II: Gradient Analysis



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7.3 ROOT CAUSE ANALYSIS ON FIELD ANOMALIES

During the analysis of all the data collected from the SCT trial, several field anomalies were observed. These anomalies in bearing temperature trending do not correlate to bearing data observed in the lab to date. This unexpected temperature trending was observed in several different ways, one of which is in this case R2, highlighted in green in Figure 15. This shows on the westbound trip from Melbourne to Perth, indicated by the first series of data in the graph, this bearing was the hottest on this particular wagon. However, on the eastbound trip, the same bearing in the same wagon position ran the coolest of the lot. Several theories have been discussed to explain this condition, is it non-concentric, is the seal lip generating torque rotating in one direction over another, or others. However, this type of root cause analysis will continue for this and other anomalies found in the field data. It is believed that through analyses such as these that pre-emptive maintenance decisions, rather than reactive maintenance and train stoppages are the benefit of widespread utilization of condition monitoring.

36. Additionally, the report indicated that “IONX is recommending the trial be extended to continue for an additional 3 months. This extended period of time will allow IONX to focus on all the improvements listed below in Future Work, including improved alarms on CMU, improved predictive algorithms, and root cause analysis on field anomalies.”

37. Exhibit 2050 (CTRL00100987.0001) is a copy of the 90 day report titled “SCT LOGISTICS BEARING CONDITION MONITORING TEST TEST REPORT.” On July 19, 2010, the 90 day report was submitted to SCT Logistics with a summary of results to date. The response from this report was positive, and SCT Logistics had agreed to continue the trial.

38. The field tests continued, and the data obtained via these tests was continually analyzed in order for improvements to be made to the algorithms. On August 2, 2010, I receive an email from Ron Bury concerning a triggered alarm. Ron Bury indicated that the crew inspected the vehicle and determined that the

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bearing was hotter to touch than the others. After reviewing, we found that the sensor did not have the correct thresholds because it did not receive the over-the-air command IONX sent to all bearing sensors on April 15, 2010. Exhibit 2052 is a copy of this email exchange. In response, the team discussed bearings that had higher temperatures and when and where (including direction of travel) these higher temperatures occurred, and we were analyzing data to determine if we were able to see any patterns appearing for bearings in the same position on different cars. We also requested the advice of the research team at UTPA regarding the data. Exhibits 2076 and 2077 are emails I sent or received that demonstrate these discussions.

39. In August 2010, we were working on altering the temperature thresholds of the bearings in order to help prevent the triggering of false alarms. When an alarm is triggered which requires the attention of the train crew, this can cause a significant delay in the train's movement. When this alarm is due to a temperature reading below that which would have necessitated the alarm, the alarm is false and the delay unnecessary. We were continuously studying the recorded temperatures in order to update our temperature thresholds to help prevent false alarms. The installed systems would then have to be updated with these updated thresholds. When the systems were not updated, this would result in false alarms. Throughout the research and development of our systems, we would periodically

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receive indications of false alarms and would need to address them. On August 24, UTPA sent to us a presentation that summarized the results of their validation work on these changes. Exhibit 2079 is a copy of the email I received attaching the presentation. In late August 2010, we decided to have UTPA examine and run to failure the 130L bearing pulled from service in Australia in July. Exhibits 2081, 2082, and 2083 are emails documenting these discussions.

40. In September work continued at Amsted acquiring data from the sensor units in the field and refining the algorithms used to analyze the data. I spent the first few weeks of September developing additional work items to further this work for Amsted and UTPA. UTPA sent an updated presentation of analysis results to us on September 20, 2010. Exhibit 2084 is a copy the email attaching this presentation. Exhibits

41. Additionally, Between September 11, 2010 and September 23, 2010, a team from Amsted including Brent Wilson traveled to Australia and New Zealand. I was told that, during this trip, the Amsted team there met with members of SCT Logistics and we continued research and development of the product. One of the objectives of this trip was to identify units that required battery changes for a trip I would be making to Australia in November.

42. By October 2010, we were working on upgrading the algorithms for use in the already-installed systems, with the intent of upgrading those systems

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with the upgraded algorithms. These upgraded algorithms would feature the latest developments from the first 6 months of testing at SCT and years of university research. To further this work, on October 6, I sent maintenance logs for the cars outfitted with Amsted's condition monitoring system to UTPA for comparison to the anomalies the IONX bearing condition monitoring algorithm had been detecting. Exhibit 2085 is a copy of the email I sent. Also on October 6, I sent an email to Paul Hubbard stating that that UTPA would perform the tear down of the 130L bearing. Exhibit 2088 is a copy of my email to Mr. Hubbard. Through the middle of October, UTPA was conducting a tear down of the 130L bearing I discussed above and provided a full report on October 19. Exhibit 2086 is a copy of the email attaching this report. UTPA also sent updated results on their analysis of SCT data on October 29, 2010 for a conference call that day. Exhibit 2087 is a copy of the email I received.

43. By November 2010, we considered other locations to place the WSN for measuring bearing temperature to make sure we could accommodate various bearing types, which were produced in a variety of sizes. We had UTPA set up a test to run during the regularly scheduled bearing tests to look at temperature on the end cap. We used that to log the temperatures and compare to the other WSN's on the bearing adapters. Exhibits 2093 and 2094 are copies of emails discussing these tasks. On November 5, 2010, I emailed the Bearing Condition Monitoring

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Six Month Technical Report to my co-inventors and Doug Cummings, summarizing the trial setup, previous and new results, improved predictive algorithms, and next steps, including recommending ongoing data collection to aid in development of future algorithms. Exhibit 2099 is a copy of this email. The next day I sent a “watch list” to UTPA of 26 bearings, and I directed UTPA to update this “top ten” list every 30 days. Exhibit 2100 is a copy of this email that I sent on November 6, 2010. UTPA also performed a tear down inspection on the bearings that had been used in the second round of the Australia Bearing testing and found evidence of metal to metal contact, which explained why that bearing was running hotter than the rest. Exhibit 2096. Martin Reed emailed our team on November 8, 2010 about the importance of continuing to run the bearings to failure, since that would be the most important piece of information that a customer would want, as it would indicate that IONX correctly signaled a distressed bearing that had then proceeded to failure, indicating a successful product. Exhibit 2101 is a copy of this email that I received from Martin Reed on November 8, 2010. On the same day, I received an email from Constantine Tarawneh that the Australia 130L L3 node 6 bearing seized when run for 29,000 miles after being identified by our algorithms. This indicates that the algorithms were effective in identifying potential burn off. Exhibit 2097 is a copy of this email. Then on November 9, 2010, Constantine Tarawneh sent pictures of the

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progressively worsening raceway during each of four teardowns. Exhibit 2098 is a copy of this email. UTPA's report to us on November 26, 2010 provided a helpful summary of the results for Railcar 130L, with tables summarizing the results of the three alarm levels and temperature history plots. There was an issue with the rear of the car since three of the four bearings seemed to have higher operating temperatures than the fleet average, and therefore detailed railcar inspection and teardown was recommended. Exhibit 2103 is a copy of this email that I received on November 26, 2010 from Constantine Tarawneh. Also in November 2010, William LeFebvre, Doug Cummings and myself met the CEO and several directors of SCT Logistics. We presented to them this technology we had developed and the value of its use in their operation. This was a culmination of the work we had developed up to this point. We reviewed the state of the technology with the system's features and capabilities, explained the customized alarm thresholds and communications system for the Australian rail market", and discussed the clear guidelines for how locomotive engineers should respond to system alerts. Conclusions were positive.

44. By December 2010, we were continuing to review the accuracy and completeness of the SCT algorithms and check for functions that are portable to a microprocessor. Exhibit 2105 is a copy of the email I sent to UTPA on December 1, 2010 requesting these files. UTPA reported performance issues with several of

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the bearings showing high temperatures. Exhibit 2106 is a copy of the email Constantine Tarawneh sent to Brent Wilson and me on December 6, 2010 indicating this. On this date UTPA also updated the results from their earlier analysis summarizing the 130L Railcar performance, including bearing temperature histories and alarm level summaries. Exhibit 2107 is a copy of the email attaching this presentation that Constantine Tarawneh sent to Brent Wilson and me. During this time, we had UTPA watching alarms levels very closely so that we could get closer to setting up proper alarm thresholds, although we believed that the alarm levels that we were experiencing at the time were likely caused by small spalls that were not typically very detrimental. Exhibit 2108 is a copy of an email chain sent from Constantine Tarawneh to the team discussing the alarms, and Exhibit 2109 is a reply from my co-inventors discussing the spalls.

45. In January 2011, there was extensive testing on the 130L Node by UTPA, including the 130L Node 1 before and after set out, and UTPA agreed to provide us with 10-day weekly reports. Exhibit 2110 is a copy of that IONX Update, emailed from Javier Kypuros at UTPA to the inventors on January 5, 2011. Around this time we decided to re-plot the historical data to see if we could gauge the rate at which the bearings on the watch list were degrading. Exhibit 2111 is a copy of a January 6, 2011 email sent from Javier Kypuros to the inventors including the “monthly checklists”, which included Fleet-Wide Level 3 Report

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Criteria. We were continuing to analyze and process data from the UTPA and field tests through new advanced algorithms, and prototype parts that had been running were not showing signs of trending data. We detected a possible truck issue, where all of the bearings were running statistically hotter than others. Javier Kypuros sent the inventors another IONX Update on January 13, 2011 with Fleet-wide report criteria including observations and analysis. Exhibit 2113 is a copy of this report. By January 2011, we had run a 10-month extended trial of IONX wireless technology fitted to SCTL wagons measuring real time package bearing temperatures during operation across parts of the ARTC standard gauge network.

46. On February 14, 2011, I requested slides from Javier Kypuros on problematic cars that were reporting erroneous readings for long periods of time, around -190F, because I wanted to reproduce the error. I also requested a summary of how the 130L truck data was doing over the previous three months so I could compare it to the fleet average. Exhibit 2114 is a copy of the email where I requested these slides and the summary. At that point I sent an email to my co-inventors reporting that the motes were still reporting, but that the data was not coming in correctly. Exhibit 2115 is a copy of that email that I sent to Brent Wilson and William Lefebvre on February 14, 2011. On February 16, 2011, C. Tarawneh sent Brent Wilson and me detailed analyses on railcar performances for SCT. Based on these analyses, it was recommended that further tests be

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performed. Exhibit 2117 is a copy of an email attaching the analysis “SCT 77H RAILCAR PERFORMANCE 01/25/11,” and “SCT 130L RAILCAR PERFORMANCE 2/16/11.” On February 17 and 18, 2011, my co-inventors and I sent several requests to UTPA for continued testing and analyses. Exhibit 2118 is a copy of an email I sent to Constantine Tarawneh requesting statistics regarding the difference in energy across different temperature ranges, Exhibit 2119 is a copy of Dr. Tarawneh’s reply alerting me that the results would not be exact because of variations in running temperatures, and then Exhibit 2120 is a follow up email I received from Dr. Tarawneh attaching a table with the energy statistics I had requested. Exhibit 2121 is a copy of my reply. By February 2011, by using the IONX system, we had identified a league table of how well the bearings are performing. On February 21, 2011, Constantine Tarawneh emailed me a chart of the Level 2 Alarm violators, noting that UTPA hired someone to look into the SCT data and prepare presentations and tables of abnormalities. Exhibit 2122 is a copy of this email. We continued our weekly conference calls at this time, and the slides during this time included an IONX Update that reported issues with some of the nodes as well as node calibration data. Exhibit 2123 is a copy of the email Javier Kypuros from UTPA sent me with slides for the weekly conference call on February 23, 2011. Towards the end of the month, UTPA reported that they should be starting the low ambient calibration soon. Exhibit 2124 is a copy of a

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February 25, 2010 sent from Constantine to Brent Wilson and me describing how the UTPA is a unique testing facility that allowed us to vary the ambient temperature from 0 to 130 degrees F.

47. Weekly conference calls with the UTPA team continued through March. Exhibit 2125 is a copy of the email I sent to the team scheduling this call. On March 15, 2011, I sent an email to my co-inventors directing them to review a slide on energy reductions in bearings at higher temperatures. Exhibit 2126 is a copy of this email. By the end of the month, I reviewed the maintenance data on the SCT fleet and noted that 13 wheel sets had been changed out due to wheel defects, so the bearings were removed, and I alerted the UTPA team to make sure they were not comparing old bearings to new bearings. Exhibit 2127 is a copy of this email, sent on March 30, 2023 to the UTPA team. Brent Wilson replied to my email requesting that they inspect the 130L truck while it was out of service for anomalies. Exhibit 2128 is a copy of this email, sent on March 30, 2011.

48. By April, 2011, we were continuing to monitor bearing temperatures with SCT Logistics. We updated SCT with a status, reporting that the IONX Bearing Condition Monitoring system had been running successfully for twelve months. We identified a car to be monitored do to a poor performing end-car, and recommended a third-party teardown of the assembly. We also notified SCT of three WSN bearing sensors that had left the network and identified them as isolated

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incidents. Exhibit 2130 is a copy of the email I sent to SCT with the report.

During this time UTPA sent me a calibration plot of new nodes depicting the bulk of the cold temperature data that had been collected thus far, and this showed that the calibration curve was good even at low temperatures. We were pleased with this data. Exhibit 2132 is a copy of an April 14, 2011 email from Constantine Tarawneh to me with the calibration plot results. We continued the weekly UTPA conference calls at this time as well, and during this time the IONX Update slides included the calibration curve and depicted how well the nodes were following the bearing cup temperature. Exhibit 2134 is a copy of the email Javier Kypuros sent me on April 20, 2011 with the attached slides for the conference call on that day. Exhibit 2135 is a copy of the email Javier Kypuros sent me on April 20, 2011 with the attached slides for the conference call on that day. I forwarded both of these emails to William Lefebvre in May. On April 21, I updated the Amsted team that the "IONX Bearing Condition Monitoring system has been running successfully for twelve months" and identified additional issues regarding sensor units dropping from our network, likely due to battery exhaustion. Exhibit 2133 is a copy of my email attaching this status update.

49. By May 2011, we were still continuing to monitor bearing temperatures with SCT Logistics. UTPA prepared presentations for us with an updated analysis of the performance of 10 of the SCT Railcars, with observations

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and recommendations. Exhibit 2139 is a copy of the email I received on May 16, 2011 from Constantine Tarawneh with the presentations. On May 18, 2011 we had our conference call with UTPA to discuss the updated IONX Report that continued to include node temperature calibration and data analysis. This report showed a weak correlation between speed and temperature above ambient, and also reported plots above ambient vs. speed, showing very high temperatures at 0-20 kph. Exhibit 2140 is a copy of the email sent to me from Javier Kypuros attaching this report.

50. In the beginning of June, our team and UTPA discussed various equipment needed for some new tests to test the calibration of the motes using unmachined adapter surfaces and machined surfaces. Exhibit 2141 is a copy of an email I received from Constantine Tarawneh on June 1, 2011 discussing the new tests. On June 15, 2011, Constantine Tarawneh again emailed us presentations with updated analyses of the performance of 10 of the SCT Railcars, including observations of trends and recommendations., Exhibits 2143, 2144, 2145, and 2142 are copies of these emails. On June 22, we received another update for presentation at a conference call that day. Exhibit 2146 is a copy of an email from Javier Kypuros attaching this presentation.

51. Conference calls with UTPA to discuss the SCT Data Analysis continued in July, with an IONX Update Presentation reporting on node

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temperature testing and battery life. Exhibit 2147 is a July 6, 2011 email I received from Javier Kypuros with the slides for the call. On July 8, 2011 I emailed Doug Cummings, reporting that the 10 cars that we were testing were still giving us valuable data, and I believed that the bearing teardowns and inspection of the bearings that were close to tripping our algorithms would help us figure out if we were on the right track. Exhibit 2148 is a copy of an email I sent to Doug Cummings on July 8, 2011 discussing the data and the bearing teardowns. This email also discussed the replacement of bearing temperature nodes on SCT's wagons. I continued to discuss this with my co-inventors, and we determined that we needed to let the bearings get closer to failure to refine the algorithms, and that since previous bearing teardowns set the upper bounds, these would set the lower bounds for refining the algorithms. We discussed collecting and analyzing bearings on either side of the current algorithm thresholds. On July 13 and 19, 2011 there were more conference calls, and Javier Kypuros emailed my co-inventors and me more IONX Updates with node temperature testing data and a suggestion to modify the algorithm used to calculate heating rate. He also reported that one WSN was configured to report temperature readings every 15 seconds. Exhibits 2150 and 2151 are copies of these emails I received from Javier Kypuros. Around the end of July, my team discussed the best location of the ambient surface temperature in consideration of cost, and we decided that the majority of the

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algorithms could be pushed onto WSN, and that two algorithms needed to send data points to the CMU every 6 hours. Exhibit 2152 is a copy of an email chain between my co-inventors, Dan Maraini, and me that I received on July 20, 2011, where we discussed these topics. And finally, on July 27, 2011 Constantine Tarawneh sent Brent Wilson and me a presentation that summarized the node temperature testing data. Exhibit 2153 is a copy of this email.

52. Development of the inventions continued toward building a system that would work, and, by at least August 2, 2011, we believed the condition monitoring system would work. On this date, I sent, to B. Wilson, D. Cummings, W. Lefebvre, and J. Monaco, an email stating: “As a follow up from our conference call, please review the attached update report for SCT. It highlights the successes of the trial and a direction forward.”

53. Exhibit 2154 is a copy of this report. Demonstration that the concepts disclosed and claimed in the '223 Patents is further reflected by this report, which stated the following conclusions:

- “IONX has developed and proven a bearing condition monitoring system with action instructions for any critical alerts”
- “IONX has developed condition based metrics to assess performance before a bearing is a burn-off risk”

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- “IONX has identified other components (such as bogies) that effect bearing performance, and can now identify when those components are the cause”
- “Once these maintenance actions have been performed; the problematic bearing has dropped off the watch list with a 100% success rate”
- “The IONX bearing condition monitoring system has identified where good bearings were flagged (a false positive) by wayside acoustic monitors”
- “Results of the development team has found only 40% of wheel set change outs improve bearing performance”
- “Future progress for the pilot include bearing inspections of four bearings on the watch list”
- “Direction of the pilot is to upgrade the equipment in January”

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I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed 11/02/23 at West Chester, Pennsylvania.

DocuSigned by:

DF0F8A597EC244Q...
Andrew Martin



ANDREW H
MARTIN

Contact Me



Andrewmartin80@gmail.com



+1.610.350.7261



West Chester PA

Skills



DevOps



Tableau



Power BI



SQL



Python



Matlab



Photoshop



Solidworks



Autodesk



ANSYS

Interests

- Outdoors enthusiast
- Professional Ski Instructors of America certified
- Association of American Railroads member
- American Society of Mechanical Engineers member
- American Chemistry Council – Conference Presenter

Experience

Senior Director of Customer Success

Amsted Digital Solutions

August 2021 – Present

West Chester, PA

- Design and run a new Customer Success program for elevating our client's experience with our **SaaS** solutions (management of logistics and maintenance for supply chains)
- Manage a team who have become trusted advisors to our clients with **user empathy** to understand their business and the challenges they face
- Partner with clients that need expertise in streamlining processes and automating systems that manage their supply chain
- **Define KPI's and metrics** to measure our solutions performance in the client's experience
- An expert in working as a **consultant** to embed our solutions in clients process and grow the business with deeply integrated software and sensor solutions

Director of Technical Sales and Solutions

Amsted Digital Solutions

May 2017 – August 2021 (4.25 years)

West Chester, PA

- **Set vision and strategy** for sales of software, telematics and **industrial IoT** devices to meet our long-term objectives
- Manage multi-million-dollar **B2B** accounts to deliver integrated solutions of hardware and software around client requirements to maximize value to that client
- Create rich data visualizations to present a technical and financial value proposition of our solution to the customer over their existing systems
- Identified shifts in market trends and customer's requests to set new feature / product requirements or start the NPD process
- Manage all functions of technical support team for existing products, including people management of multi-tier support teams, issue trend analysis, and managing resolution workflows

Application Engineering Manager

IONX LLC

November 2009 – May 2017 (7.5 years)

West Chester, PA

- Developed a new Application Engineering department as a team with technical and business skills to demonstrate the value of our telematics and remote sensor products to customers
- Worked as the **Product Management team** to own the requirements of our products and give the users perspective to the internal design teams
- Created **product strategy** and **roadmap** for product development team to execute
- Responsible from the full **product lifecycle** from **R&D to market launch**
- Captured **case studies** that demonstrate a true picture of value with data visualizations highlighting KPI's met, real RoI, net present value and more
- Started the **Machine Learning** team for simulation, optimization, and forecasting of customer's supply chains using the latest in **AI / ML** toolsets
- Travel internationally with customers to identify new opportunities and unmet needs which our products can solve

Mechanical Design Manager

IONX LLC

April 2008 – November 2009 (1.6 years)

West Chester, PA

- Lead mechanical team with an **Agile** process to develop sensor products to meet the demands of the railroad industry
- Manager of Mechanical Engineering Department; including **requirements documents**, prototyping, design reviews, ISO document control, lab and field testing, compliance testing, design for manufacturing, product launch
- Supervisor of all field testing in North America, South America, and Australia
- Consulted regularly with customers to determine their current and future needs; and position our product development strategy to meet customer demands
- Prepared cost analysis for development and compared to market analysis to identify return on investment for a new product or feature

Product Development Engineer

December 2005 – April 2008 (2.3 years)

IONX LLC

West Chester, PA

- First employee at a **startup company: Building a business**, created proof of concept designs, rapid prototyping to demonstrate our company's adaptability to customer requirements
- Designed and patented complex sensor systems for condition monitoring of railroad components using embedded sensors to measure bearing, wheel and truck performance, as well as railcar weight, imbalanced and overloaded cars.
- Senior Mechanical Engineer in charge of all mechanical aspects of products in development from concept to launch; including requirements, design, prototyping, lab and field testing, customer validation, and launch
- Supervisor of the field-testing team for testing new products on railroads across North America using data loggers and calibrated transducers to compare the output from our products to the calibrated transducers
- Sensor development: weight, temperature, acceleration, position, proximity, rotation, pressure, GPS

Application Engineer

November 2003 – May 2005 (1.5 years)

ANSYS Inc

Canonsburg, PA

- Tested and re-engineered customers virtual prototypes with ANSYS FEA tools
- Saved customers such as Technip Inc. over \$2 million by finding faster ways to design components for their offshore vessels
- Created best practices guide: "Time savings in new product development through frequent simulation"
- Developed web-based presentations and training materials of complex FEA software features for instructing advanced level users

Education

University of Pittsburgh, Pittsburgh, PA

MS Industrial Engineering

University of Pittsburgh, Pittsburgh, PA

Joseph M. Katz Graduate School of Business

Master of Business Administration, Marketing

University of Pittsburgh, Pittsburgh PA

Bachelor of Science, Mechanical Engineering

Saint Vincent College, Latrobe PA

Bachelor of Arts, Mathematics, Minor in Physics

Publications

- Wilson, B. Martin, A. "Bearing Condition Monitoring Using Wireless Technology to Reduce the Risk of Bearing Failure" (ASME Conference: RTDF2012 Paper Number: RTDF2012-9441)
- Kypuros, J., Tarawneh, C., Zagouris, A., Woods, S., Wilson, B., Martin, A. "Implementation of Wireless Temperature Sensors for Continuous Condition Monitoring of Railroad Bearings" (ASME Conference: RTDF2011 Paper Number: RTDF2011-67017)
- Kypuros, J., Tarawneh, C., Zagouris, A., Woods, S., Wilson, B., Martin, A. "A Successful Implementation of Continuous Bearing Temperature Monitoring Using IONX Technology" (ASME Conference: RTDF2010 Paper Number: RTDF2010-XXXX)
- Martin, A. "Time savings in product development through frequent simulation" (MS Thesis, U of Pittsburgh, 2005)
- Hayashi, S., LoPresti, E., Martin, A., Simpson, R., Sharma, V.K. "Composite sensor for drop-off detection in intelligent mobility aid" (Proceedings of the RESNA 2004 Annual Conference)
- Patent: US11615341, US7698962B2
– Flexible sensor interface for a railcar truck
- Patent: US12861713, US9026281, US9663092, US14684994
– Railcar Handbrake Monitor
- Patent: US9365223, US15158018, US13842427, US9981673
– System and Method for Monitoring Railcar Performance
- Patent: US15108065, US10137915B2
– System and method for detecting operational anomalies in train consists and railcars
- Patent: US20190225248A1
– Discharge Gate Sensing Method System and Assembly
- Patent: US20150232079A1
– Railcar Handbrake Monitor
- Patent: US20180319414A1
– System and method for building managing a train consist
- Patent: US15166933
– Train and rail yard management system
- Patent: US16510838
– Brake monitoring system for railcars
- Patent Application: 17/510,096
– Sensing method, system and assembly for railway assets
- Patent application: US20140111356A1
– Railway tank car security device
- Patent application: WO2015025188A2
– System and Method for Monitoring Railcar Performance
- Patent application: 10/873,024
– System and Method for Monitoring Wheel Damage and Detecting Derailments for Railcars
- Patent application: US20160325767A1
– System and method for detecting operational anomalies in train consists and railcars

Patents