Amazon Web Services and National Football League to Discuss New Partnership to Transform Player Health and Safety at AWS re:Invent 2019

Company Participants

- Andrew Jassy, CEO
- Matt Wood, VP of Artificial Intelligence

Other Participants

- Jeff Crandall, Chairman of the Engineering Committee, NFL
- Jeff Miller, Executive Vice President of Health and Safety Innovation, NFL
- Roger Goodell, Commissioner, NFL
- Unidentified Participant, Analyst, Unknown

Presentation

Unidentified Participant

Ladies and gentlemen, please welcome, Andy Jassy.

Andrew Jassy {BIO 15111610 <GO>}

Thank you, guys. And thank you for coming. I appreciate it's been a great week here at re:Invent. And we appreciate your spending some time with us today.

So sports, to me, is an amazing storytelling forum. And if you think about -- if you're a sports fan -- I'm a very passionate sports fan, a New York sports fan because I'm from New York. It's an incredible roller coaster of emotions. You get to see giants face off against each other. You get to see David versus Goliath. You've huge upsets. You have heartbreak and agony. You have euphoria. You have all of those emotions. And it's also an amazing way to bond. Some of my very best memories in my life are going to New York Giants games and New York Rangers games with my dad. I still remember the conversations we had going to the stadium back and forth, just has been a bond. Even if my dad is now 82, we go to sports events all the time. And it's something we share and have shared our whole life. And I share it with my son as well.

And I also think it's an amazing community builder. I think in a world like we live in today, where there's so much polarization, one of the few places where people from every background and every political view come together as one in a community is

when you're rooting for a sports team. So sports, I think, has an incredible place in our society.

And in AWS, we've been helping various sports teams, sports broadcasters and leagues use AWS for digital transformation and changing their fan experiences and changing their analytics and machine learning for a long time. We've done it with baseball and hockey and basketball and car racing and sailing. And of course, with football as well. And one of our -- I think one of the most sophisticated organizations in sports and out of sports and how they use technology and evolve their customer experience has been the NFL. And it's been really an honor and a privilege for us to work with the NFL on a number of dimensions over a bunch of times.

So to share more about our partnership together, it's my privilege to welcome to the stage, the Commissioner of the NFL, Roger Goodell.

Roger Goodell {BIO 1817738 <GO>}

Hi, Andy. Thank you.

Andrew Jassy {BIO 15111610 <GO>}

Thanks for being here, Roger. I appreciate it.

Roger Goodell {BIO 1817738 <GO>}

Yes. My pleasure.

Andrew Jassy {BIO 15111610 <GO>}

So thanks for coming. I appreciate it.

Roger Goodell {BIO 1817738 <GO>}

My pleasure. Glad to be here.

Andrew Jassy {BIO 15111610 <GO>}

Football is the most popular sport in the United States and increasingly around the world. And if I think about the way that you have relentlessly worked on changing the customer experience as a fan experience over the last number of years, it's remarkable. I remember as a kid growing up, I mean, if you watch TV, you actually didn't know what the score was. You kept waiting until they flash the score. And there was no yellow line for the first down mark. Are we just -- it's radically different. And I think a lot of that...

Roger Goodell {BIO 1817738 <GO>}

Which is (inaudible) we wait until Monday night to see the highlights. Remember, it's what it used to be.

Andrew Jassy {BIO 15111610 <GO>}

Yes, I remember that. I'd be calling sports phone every 5 minutes, paying $1 a minute to hear the scores. Actually, better said, my dad was paying a $1 a minute at that age. But you radically changed the customer experience. And we love what we've been working on with you for a while and Next Gen Stats.

Questions And Answers

A - Andrew Jassy {BIO 15111610 <GO>}

Share kind of how that's evolved and how you've used Next Gen Stats and other innovations to change the fan experience.

Q - Roger Goodell {BIO 1817738 <GO>}

Well it's all about trying to bring the fan closer to the game and give them some other way to engage with the game. And they want access, of course. But they want information. And AWS has been able to work with us with Next Gen Stats to be able to give us insight that we never had before: how fast a player is running; the separation that a receiver and the defensive back may have; probability of a catch, we saw some of that up on the screen just before we started. And I think the fans have really taken to that. And our broadcasters have taken to that. Media partners have been really interested in how you take this new data and make it a better production and make the fan feel like they're more a part of the game and understanding it. And when you get an opportunity to see somebody running 22 miles an hour, which I think is the record this year, according to AWS. And that's -- I don't know the last time you ran 22 miles per hour.

A - Andrew Jassy {BIO 15111610 <GO>}

Not recently.

Q - Roger Goodell {BIO 1817738 <GO>}

Not recently. So -- but you see that. And you really take away that these are incredible athletes doing incredible things. And that's, I think, the power of what we've created with you all. And I think there's so many more opportunities beyond that for us.

A - Andrew Jassy {BIO 15111610 <GO>}

I agree. One of my very favorite of the Next Gen Stats is that catch probability metric. And I love -- as a New York Giants fan, I love that Next Gen Stats is able to use the machine learning algorithms created in AWS to project that famous OBJ catch, the Odell Beckham Jr. catch, against Dallas had a 0.4% catch probability, which means effectively, 4 out of 1,000 times, he would catch the ball, which is pretty amazing.

And as Roger said, we've spent a lot of time together as our organizations and continuing to work on how we can evolve the game and be a part of changing things. And we -- we've looked at what we were doing together and said, "Are there other things that we can do to move the needle?" And so we talked a lot about that. We said, "What can we do with AWS' cloud computing and machine learning capabilities with what the NFL has, both with regard to historical and current data and insight into the game?" And we're excited to announce a new strategic partnership together, which is going to combine AWS' cloud computing and machine learning with the NFL's data and insight into the game to work on transforming player health and safety.

And so we're excited about what's possible there. And I thought it would be useful for you to help us understand how is the partnership and what we're going to do together build on what you've already been doing. It's, obviously, a big priority for the NFL and has been for a long time.

Q - Roger Goodell {BIO 1817738 <GO>}

Well it's our #1 priority. How do we make the game safer for our current players, obviously, of -- for the next-generation of players. And frankly, well beyond the game of football?

We think what we do here will make every sport safer and frankly, even beyond that. But for us, what we see the power here is to be able to take the data that we've created over the last decade or so with that not only extraordinary distant it's pure data. But it has video attached to it. And we now have sensors. And when you can take the combination of all of that, I think the possibilities are enormous. And that's what you guys specialize. You -- that's what you guys do.

We're pretty good at football. We're pretty good at collecting that data. But we want to use that data to now change the game. And I think that's what's exciting to me about this relationship. There are very few relationships that we get involved with, where the partner and the NFL can change the game. And it'll be changing the way it's played, it'll be the way it's coached, the way we prepare our athletes for the game. And although that is, I think, going to be something that's going to be very exciting as we look to the next 100 years of the NFL.

A - Andrew Jassy {BIO 15111610 <GO>}

Yes. We're excited about it as well and the potential for it. And this is, obviously, an important strategic priority for you. Just to share a little bit how you thought about who to partner with. And what the process was like?

Q - Roger Goodell {BIO 1817738 <GO>}

Well you'd be happy to hear. When we're looking at partnerships, we always look for best in class. So that is a compliment to AWS.

A - Andrew Jassy {BIO 15111610 <GO>}

Thank you. Yes.

Q - Roger Goodell {BIO 1817738 <GO>}

And it is how we believe in. When we look at the landscape, we wanted to go with the best in class. So that's #1 for us. Two is we really feel strongly about trying to align our interest with that partner. You bring great technology. You bring great machine learning, stuff that we don't have in the NFL. So we want to be able to work with you to make 1 plus 1 equal 5. And so we believe that will work very well for us. Then we, obviously, just want, at the end of the day, to have an impact. We want to know that in this relationship, we can impact AWS, we can impact the game and we can together do something very powerful.

A - Andrew Jassy {BIO 15111610 <GO>}

Yes. In my keynote on Tuesday, which I'm sure you watched on a livestream, yes.

Q - Roger Goodell {BIO 1817738 <GO>}

I did see that.

A - Andrew Jassy {BIO 15111610 <GO>}

It's on. I'm sure it was high (inaudible), yes.

Q - Roger Goodell {BIO 1817738 <GO>}

You told me it was 2.5 hours, Andy. I watched it on the (flight homes).

A - Andrew Jassy {BIO 15111610 <GO>}

Yes. Along with (St. Dodo). In the keynote, one of the things we talked about is that when you're making a big transformation, it really starts foundationally with the leaders deciding that they want to make that transformation and setting aggressive goals from the top down.

And one of the things I've always been impressed about you, Roger, is that you're super curious about technology. Really, I think you're quite happy with where the game is. But also, every time we talk, you're thinking about how to change the fan experience and how it can be better and leaning into it. And that's, by the way -- I mean, I would say I get a chance to meet with lots of leaders and lots of industries. And you would think that would be the norm. But it's not. And I really appreciate it about you. And I'm just curious how you think about innovation and how the league thinks about innovation.

Q - Roger Goodell {BIO 1817738 <GO>}

Well it's sort of -- I was giggling because you said -- and I know my staff would giggle with you, is that I seem very happy with where we are with the game. I am never happy or satisfied with where we are. I always feel like the NFL, in particular, has so much more potential. And we have to unlock that potential. And I think that's what this relationship can do is unlock all of the work that we've done in building this

database and actually work to extend our efforts to, obviously, prevent injuries, to diagnose injuries and to treat injuries; and to come up with better medical standards. And better practice methods and better equipment.

You're going to hear from the engineers in a few minutes. And the work that they've been able to do to create this engineering road map to improve the game is having dramatic impact. We've already seen it in a reduction of concussions of 30% last year. We're continuing to see how we can do that with lower extremity injuries, which are really the bulk of the injuries. And we believe we can do that by combining it in this partnership to make sure we understand how the injuries occur and what we could do to prevent them. Even to a point, as you know much better than I do, could we create the Digital Athlete? Could we find out more about predictive analysis that will allow us to understand, is it possible this individual is more susceptible to an injury? Maybe on the surface, or in these cleats or at that position.

So all of that is exciting for us. And it's not far away. And it's something we think is in our grasp. In this relationship, I believe, we will accelerate that.

A - Andrew Jassy {BIO 15111610 <GO>}

Yes, I agree with you. I think, it's -- some of the things I'm excited about that we're going to do together is just using computer vision algorithms. And then alongside of things like...

Q - Roger Goodell {BIO 1817738 <GO>}

You're going to get over my head real quick.

A - Andrew Jassy {BIO 15111610 <GO>}

I am. But alongside some of the services like SageMaker we have where we build algorithms to try and predict what causes concussions and lower extremity injuries and the Digital Athlete that you mentioned, too, just creating a virtual composite model of athletes. So you can understand -- you can simulate different collisions and different angles and different types of plays and what it looks like for a normal gate of a player versus somebody who's maybe be impacted by injury. It just, I think, has the chance to really transform player health and safety.

And so super excited about the partnership and excited about what we're embarking on together today. And as Roger said, we're going to call up some of the experts now. And I'm going to welcome to the stage -- I'm going to welcome Jeff Miller, who's the Executive Vice President of Health and Safety Innovation for the NFL; Dr. Matt Wood, who's the VP of AI Services here in AWS; and Dr. Jeff Crandall, who's the Chairman of the Engineering Committee for the NFL. And they're going to share a little bit more detail. Thank you, again.

Q - Roger Goodell {BIO 1817738 <GO>}

My pleasure, Andy. It's great to be here. Thanks again.

A - Andrew Jassy {BIO 15111610 <GO>}

Thank you. God bless you.

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Q - Jeff Miller {BIO 22261500 <GO>}

Good afternoon. I'm Jeff Miller, Executive Vice President for Health and Safety Innovations at the NFL. And I can testify to the fact that Roger Goodell is relentlessly unsatisfied.

We're going to continue the conversation that we started a few minutes ago. I want to thank Andy Jassy, AWS, the team that we've had an opportunity to work with as we've developed this partnership over the last few months. We could not be more excited about what the future holds for football, for the health and safety of our athletes and for the game as a whole.

With that, let me introduce a couple of our special guests who are going to get into some of the detail around this work. This is Matt Wood, who is Vice President for Artificial Intelligence here at AWS; and a good friend of mine, Dr. Jeff Crandall, who's the Chairman of the NFL's Engineering Committee and a Biomechanical Engineer at the University of Virginia.

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Jeff, let me start with you. We know each other well, have worked together for a long time. About 3.5 years ago, the NFL started a project that we called the Engineering Roadmap, which was an effort supported -- a multimillion dollar effort supported by our owners to try to better understand head impacts and concussions on field and then design ways to mitigate those impacts, to try to move the helmet industry forward. And that work has been intensive. I think that we've seen a fair number -- a fair amount of success from it.

Jeff, you've been at the point person for doing this work. Can you share with the audience a little bit about the efforts so far?

Q - Jeff Crandall {BIO 1773143 <GO>}

Sure. I think it's important to understand where we're starting from. I think if you look at the NFL, collects a tremendous amount of high-quality data. And most of you are probably familiar with what they share about the play and the game information. But I think it goes right down to the player level. We have tremendous information on the equipment that players are wearing. What are the helmet models? What are the cleats? What are the shoulder pads? We know the player injury and their history. We know what's happening, how often they practice. We know what they're doing on field. We know the surfaces they run on. So we've got a tremendous database prepared. And I think on top of all that, one of the most unique resources, if you

look, is the archives of video. So not only do we have the game characterized with every play where we have multiple views of cameras. Now what we have is every player actually tracked with multiple views of cameras and angles. And so building on this, we developed a plan called the Engineering Roadmap. And the goal of that was really how do we transform. How do we improve the current state of head protection? How do we accelerate that and do it at a pretty rapid pace? And so what we did is we put a plan together. It was part of $100 million initiative that the league funded a couple of years ago.

What we did is we set up 4 basic tasks. The first task was, let's understand what's happening on field. Let's characterize the environment when players are getting injured. So what we did is we took video. We took the Next Gen Stats that you just saw. We did something called model-based image matching. And we really characterized who is getting injured, how they were getting impacted, what they were being impacted by. Then from an engineering basis, what we did is we've said, "What are the forces? What are the motions involved when players are injured?" So once we have that information, we characterize the on-field. Then the next step is how do we share that. How do we share that with people that can actually make better helmets, better protective equipment? And so what we did is we took that information. We brought it into a laboratory setting. And that laboratory setting meant we had to recreate that on-field environment using impactors and crash test dummies that manufacturers could then take in their laboratory and design to. So essentially, designing with this equipment let you reflect the on-field environment.

And I think if you look at the state of affairs of design right now, it's no longer a world where you take a prototype and you test it experimentally. So another work stream we did was let's bring this to a computational environment. Let's use finite elements. Let's recreate that environment that we studied on field in a virtual space. And so we're at a point now where we understand what's happening on field. We have the tools, both experimental and computational. The next step is how do we incentivize and motivate the development of these transformational helmets.

And so last month, a group of us had a symposium, where we kicked off a $3 million NFL helmet challenge. We really want to motivate and incentivize manufacturers, entrepreneurs. We brought all of them together with the nation's leading additive manufacturers' 3D printing.

And so we're hopeful over the next 18 months that we get to a transformational, a revolutionary element that is better substantially than anything that's on field right now. And so that's essentially where we are with the Engineering Roadmap.

Q - Jeff Miller {BIO 22261500 <GO>}

And one element that I had not anticipated when we started this work was the collection of the different data sets, not just the head impacts on field but gameplay data, the equipment that players were wearing, the frequency of those impacts, the speeds that the players we're traveling, the angles that they hit one another and such. And some of that work, which has been very laborious over the last couple of

years looking at upwards of 700 or 800 concussions on field, allowed us -- some of us who are looking at this to identify trends in the data and to do so manually.

And Jeff, if you want to just spend 30 seconds talking about some of the outcomes of that real quickly.

Q - Jeff Crandall {BIO 1773143 <GO>}

Sure. I think Jeff mentioned we can identify trends and opportunities. And so while the road map was sort of a long-term plan, what we said is are there sort of off ramps that we can implement right now and make changes to the game. So one of them would be, I think, an educational opportunity where we tested helmets on an annual basis. And we saw some that performed better than others. They were our top-performing group. And I think what we were able to do is, through an educational program with the players and teams understanding what we had for on-field data, we were able to take the players that were 41% in top-performing helmets in 2017 and moved to 99% of players in top-performing helmets this year.

Another example might be a rule change that we worked on. Historically, if you look, the kickoff returns has some of the highest injury rates. So what we did is we looked at video. We looked at Next Gen Stats. We did something called a clustering analysis, where we said, "What is it on kickoffs that makes that such a dangerous play?" We shared that with special teams coaches. We shared that with the Competition Committee. And what they were able to do was come up with the rules to change that play, such that they could keep all the excitement but remove those riskiest scenarios. I think Jeff mentioned the tedious nature. We've looked at over 100,000 helmet impacts manually. And so one of the challenges now is how do we scale that. How do we accelerate? I think that's one of the reasons why we're so excited about the AWS partnership. How do we leverage their suite of tools? How do we leverage what they're doing in AI and machine learning to help us drive innovation at a faster pace more efficiently and more broadly?

Q - Jeff Miller {BIO 22261500 <GO>}

So Matt, let's turn to you. I think we can all agree that looking at 100,000 head impacts on film is a little bit crazy. And then probably suggest that anybody who is doing it, that there has to be a better way.

A - Matt Wood {BIO 18000850 <GO>}

Quickly overwhelming.

Q - Jeff Miller {BIO 22261500 <GO>}

Quickly overwhelming. Let's talk to you about -- from your approach, what do you see when you hear about the data and the work that we've done so far and what the possibilities are?

A - Matt Wood {BIO 18000850 <GO>}

Sure. I mean, I think, first and foremost, the thing that I've been impressed most with from our partnership so far and the material work that we've done so far is just the level of drive and innovation inside the NFL. Working on these biomechanical models, a willingness to explore and wonder through this kind of exploratory world together, I think we've done some great work. And we'll continue to do more going forward.

From a machine learning perspective, machine learning, it all starts with the data. And the data of the NFL is generating the ground truth data that we've already got access to, the video troves. All of this information, it's just -- it's a raw material from which we can just continue to extract meaning insight into the game like we've been doing with Next Gen Stats. And then start to take that even further, as we start to integrate and move towards improving player health and safety.

And so whilst it's tempting to focus on machine learning, machine learning is just the frosting on the top. It's the 20%. And the 80% is all about the data. It's how you store it. And so one of the first things we've been working on is creating a data lake, which puts all of that data together in a single place, which is -- has the right access controls and right governance and is available to the sort of computation, which allows you to explore it.

Then you can get into machine learning. And if you're doing it wrong, machine learning is -- it's like driving around with your lights off at night without a map. It's -- you just -- you can go anywhere that you want. And you can explore. But you can often take a wrong turn. And you can end up in a dead end. And what we've been trying to do with services like SageMaker, particularly the new announcements that we've made this week with things like SageMaker Studio and our debugging and profiling capabilities, model monitoring and autopilot that allows you to create models automatically, we're giving the NFL the map. And we're turning on the lights to our car. And that means that we can look around corners. And as a group, with AWS and our machine learning solutions lab and the experts in the NFL, we can start to plot a course towards a safer game. And we're going to do that with the data that we've collected. We're going to do it using the computer vision models and the predictive models that we're going to build with SageMaker.

Q - Jeff Miller {BIO 22261500 <GO>}

Jeff, one of the endpoints of the map that Matt was talking about that we've conceived of is the Digital Athlete platform, which the previous panel talked about briefly. And the opportunities that, that provides in ways that I don't think have existed before to better understand how humans perform and behave. And potentially how to avoid injuries or find other trends in data based on that platform that we could potentially build together during the course of this partnership. Can you give your perspective on that for a minute?

Q - Jeff Crandall {BIO 1773143 <GO>}

Sure. I think if you look, the NFL provides a sort of unique opportunity to look at human motion, forces and injury among a population of the world's most elite athletes. And so our challenge is how do we protect those athletes. And so this

concept of a Digital Athlete that you've heard, the basic idea is that we will take a virtual representation of this population of athletes. And we will be able to simulate potential changes to the game across a wide spectrum of scenarios, both that we currently envision and those that come up in the future. This will heavily rely on the tools that Dr. Wood just mentioned, machine learning, computer vision, AI. And ultimately, what we'll be able to do is we'll be able to identify injury risk scenarios. We'll be able to predict injury risk scenarios. And we'll be able to find innovations that will make the game safer for our athletes while maintaining the high-quality of play within the game. And so I think it's not really an overstatement to say that we believe this will revolutionize the way in which we do injury prevention, player rehabilitation and play a recovery in the NFL.

Q - Jeff Miller {BIO 22261500 <GO>}

And Matt, we, obviously, focus myopically sometimes on football. Your job is to take a much broader look over at the horizon and about how tools like this that could be developed together could have applications.

A - Matt Wood {BIO 18000850 <GO>}

Yes.

Q - Jeff Miller {BIO 22261500 <GO>}

What do you think about when you conceive of the Digital Athlete?

A - Matt Wood {BIO 18000850 <GO>}

Sure. I mean, it is hard to overstate the potential of a digital twin when you're applying that to people. Exactly as we're doing with the Digital Athlete, the opportunity to create and simulate and then ask what if in different situations without putting real humans at risk and being able to do that hundreds of millions of times and get accurate results from it, it's an incredibly inventive, a broadly applicable technology. And I'm so excited that we get to build it together. It has opportunities across things like workplace safety. It has opportunity like architecture and building design, defense. But perhaps the one I'm most interested in is applying it more broadly to just health care. Once we have biomechanical information, which can be combined with health care information, you can start to do just wonderful things and start to develop more and more precise models for treatment of all matter -- all manner of diseases.

The general trend of medicine moving from a broad collection where you treat patients in groups and segments to a position where you can treat individuals with very, very precise treatments, it leads some far better outcomes for the patients. And it is materially more efficient for a health care system. So if you are looking to improve the efficiency of health care and provide healthier people, this is a fantastic technology.

Q - Jeff Miller {BIO 22261500 <GO>}

It's a incredibly exciting and grand vision as when Jeff and I started working on the Engineering Roadmap a few years, I've had a hard time imagining that we'd be sitting here today with the world's leader in machine learning and one of the most innovative companies ever to partner with them, to talk about the Digital Athlete and Digital Athlete platform and all that, that portends over the next few years.

Jeff, as we think about this journey and what comes next, looking around corners, what else could we potentially be talking about a couple of years from now, if we -- if AWS bothered to invite us back to re:Invent for an encore performance?

A - Matt Wood {BIO 18000850 <GO>}

You're welcome back, by the way. Invitation is open.

Q - Jeff Crandall {BIO 1773143 <GO>}

I think the first thing we need to do is let those video reviewers out of their dark rooms that have watched 100,000 impacts.

Q - Jeff Miller {BIO 22261500 <GO>}

That's true. That's true.

Q - Jeff Crandall {BIO 1773143 <GO>}

But I think, if you look at it, I mean, we realize our limitations right now. We mentioned the amount of data that's available to the NFL. And I think we're struggling to look at this number of databases and number of resources. And what we do is the way we do it now is we come up with hypothesis. And we hypothesis test. But we realize our limitation. So what we're really looking forward to is with the Digital Athlete platform, identifying patterns, identifying trends, identifying opportunities that we're not even aware of now. What's the unknown? So I think we're very excited to embark on that.

A - Matt Wood {BIO 18000850 <GO>}

Absolutely. Yes. That exploration is going to be a long-term partnership. That exploration and doing it quickly is going to be disproportionately important. It's a very exciting to do it with you.

Q - Jeff Miller {BIO 22261500 <GO>}

Well as we wrap up this discussion, let me thank everybody for being here and listening to us.

As you can tell, we're incredibly excited about the journey that we're going to start here with AWS. As I mentioned, if we're invited back, we will welcome that opportunity and give everybody a marker along the way, as we try to create things that haven't been created yet for the betterment of football and beyond that.

And one thing that we've pledged to do with the NFL is be incredibly transparent, as we've gone down this journey around improving the health and safety of our sport in doing so with world-class partners like AWS. So it is our responsibility to continue to do that. And we will.