FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

# A MULTI-STAKEHOLDER PERSPECTIVE ON A HUMAN + AI JUDGING SYSTEM IN GYMNASTICS

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# Samenvatting

Deze thesis onderzoekt de perspectieven die verschillende stakeholders hebben over een hybride mens + Artificiële Intelligentie (AI) jureringssysteem in turnen. De turnsport heeft al verschillende jureringsschandalen op zijn naam, deze zijn vaak het gevolg van menselijke vooroordelen tijdens de evaluatie. Artistieke Gymnastiek wordt geëvalueerd door een jury, dit brengt onvolkomenheden met zich mee. De mens is een subjectief wezen, en kan in zijn evaluatie beïnvloed worden door verschillende factoren. Vooroordelen kunnen gebaseerd zijn op nationaliteit, reputatie, lichaamsbouw, de volgorde van de presterende gymnasten, en de reputatie (Findlay & Ste-Marie, 2004). Ook kan de plaats van een jury, of vermoeidheid een rol spelen in de evaluatie van juryleden (Plessner & Schallies, 2005; V.V, 2013). Deze schandalen kunnen binnenkort verleden tijd zijn. Fujitsu en de Internationale Gymnastiek Federatie (FIG) werken samen aan de ontwikkeling van nieuw jureringssysteem dat belooft om vrij te zijn van vooroordelen. Dit systeem zal menselijke evaluatie en AI combineren, en zou al gebruikt kunnen worden tijdens de uitgestelde Olympische Spelen van Tokyo 2020. Fujitsu en de FIG geloven dat zo'n systeem niet enkel de evaluatie van prestaties zal verbeteren aangaande rechtvaardigheid en transparantie, maar ook dat gymnasten efficiënter en effectiever zullen kunnen trainen, en daarbovenop ook nog eens de sport attractiever zou kunnen maken voor fans, en als gevolg media en sponsors betrekken. Het zou dus een grote verbetering betekenen voor de turnsport dat weinig aandacht krijgt tussen Olympische Spelen.

De onderzoeksvraag van dit onderzoek luidt:

| |
|---|
| Wat denken de stakeholders over de implementatie van een mens + AI jureringssysteem in turnen? |

In deze studie worden drie stakeholdergroepen geïdentificeerd: gymnasten en trainers, juryleden en fans. Daarbovenop wordt er ook gekeken naar het perspectief van niet-fans van de turnsport. Deze doelgroepen werden geïnterviewd om naar hun mening te vragen over de ontwikkeling en implementatie van deze technologie. De nadruk van deze studie ligt op wat de implementatie van de technologie zou kunnen betekenen op vlak van populariteit en fan engagement van de sport, aangezien dit een interessante invalshoek is vanuit marketing.

De technologie zou via twee wegen tot een groter engagement van fans kunnen leiden. Enerzijds, dankzij de extra informatie die de technologie biedt. Hoe kan deze informatie leiden tot een groter engagement, door rechtvaardigheid van het evaluatieproces en de acceptatie van resultaten? Anderzijds kan de technologie leiden tot groter fan engagement, door het te gebruiken als een trainingtool. Hoe kan deze trainingtool leiden tot een groter engagement, door betere prestaties en meer media aandacht? Om deze vragen te beantwoorden werden interviews afgenomen met de stakeholders.

Uit de interviews bleek dat de technologie als een hulpsysteem positief ontvangen kan worden. Er moet een grote nadruk gelegd worden op de tool als een hulpsysteem. De meeste stakeholders willen niet dat juryleden volledig vervangen worden door machines, daarvoor werden er meerdere redenen gegeven. Ten eerste zijn juryleden bang om hun werk/hobby te verliezen. Ten tweede gaven verschillende stakeholders aan dat ze bang zijn dat door de introductie van de technologie, de magie,

en het menselijke aspect van de sport zullen verdwijnen. Uiteindelijk ligt subjectiviteit in de aard van de sport. Ten derde zijn de geïnterviewden ook niet overtuigt dat AI alle aspecten van de evaluatie van een turnoefening kan beoordelen. Er zijn heel wat vraagtekens over de evaluatie van de uitvoering, en vooral over het artistieke aspect van de sport. Hoe kan iets niet-menselijk zo iets subjectief evalueren? Daarom pleiten veel stakeholders dat de uitvoering door menselijke juryleden blijft geëvalueerd worden. Enkele respondenten haalden ook een probleem aan over de bevoordeling van gymnasten op basis van lichaamsbouw. Juryleden mogen niet beïnvloed worden door de lichaamsbouw van een gymnast tijdens de evaluatie. Ze vrezen dat een specifiek lichaamsbouw door de technologie als standaard wordt voorzien, en dat gymnasten die daarvan afwijken benadeeld kunnen worden in de evaluatie. Het is om deze reden dat Fujitsu op het wereldkampioenshap artistieke gymnastiek in 2019 van alle deelnemende gymnasten een 'Body Dimension Measurement' uitvoerde, zodat het systeem gekalibreerd kon worden op basis van al de verschillende lichaamsbouwen.
De stakeholders tonen dus wat weerstand om de juryleden te laten vervangen door de technologie. Maar het gebruik ervan als een hulpsysteem kan wel op meer steun rekenen van de geïnterviewden.

Uit deze interviews bleek vooral de extra informatie die de technologie aanbiedt heel interessant. De stakeholders noemden de ingewikkeldheid van het puntensysteem in turnen als een van de voornaamste redenen waarom niet veel mensen de sport volgen. Mensen verstaan de scores niet. De technologie zou zeker kunnen helpen om het verstaanbaarder te maken. Daarom denken sommige geïnterviewden dat de technologie nieuwe fans kan aantrekken, omdat het de sport toegankelijker gaat maken dankzij de additionele informatie. Maar er is ook een groot deel van de respondenten dat van mening is dat die extra informatie niet meer mensen zal aanzetten om de sport te volgen. Er is meer nodig dan extra uitleg om fans aan te trekken.
De geïnterviewden gaven wel aan dat ze meer vertrouwen zouden hebben in scores die de technologie zou geven dan scores van menselijke juryleden. Hiervoor werden verschillende redenen aangegeven. Ten eerste zijn ze ervan overtuigd dat de technologie accurater zal evalueren, terwijl juryleden niet foutloos kunnen jureren. Een tweede reden is dat de technologie geen vooroordelen kan hebben, of kan bedriegen volgens hen. Echter, uit de literatuur blijkt dat ook AI kan beïnvloed worden door vooroordelen, aangezien het getraind worden op data van menselijke juryleden dat vooroordelen kan bevatten. Enkele respondenten gaven aan dat doordat de scores betrouwbaarder zouden worden, nieuwe mensen zouden kunnen aangetrokken worden om de sport te volgen.

Trainers en gymnasten zijn van mening dat de technologie als een trainingtool voordelig kan zijn. Door het systeem dat hen zal evalueren op grote wedstrijden ook op training te gebruiken, creëren ze een groot competitief voordeel ten opzichte van landen of zalen die dat systeem niet hebben. Gymnasten die met dit systeem kunnen trainen zouden betere prestaties kunnen leveren op internationale wedstrijden. Betere prestaties leiden vaak tot meer media aandacht. Een goed voorbeeld van dit is Nina Derwael, sinds ze enkele Europese en wereldtitels op haar palmares heeft staan, krijgt de turnsport meer aandacht in de Belgische media. Meer media aandacht betekend vaak meer sponsors en meer geld voor de gymnasten, waardoor ze hun studies beter kunnen combineren met de sport en ook langer in de sport kunnen blijven, wat ook tot betere prestaties kan leiden. Door meer media aandacht, worden

ook meer mensen bereikt die eventueel de sport zullen beginnen volgen. Op deze manier kan ook de technologie als een trainingtool meer fans aantrekken en de populariteit van de sport vergroten.

Echter, een groot aandeel van de respondenten gaf aan dat er nog andere factoren zijn die de sport aantrekkelijk zou maken. Bijvoorbeeld nog meer adverteren en communiceren over turnwedstrijden en andere evenementen. Ook meer wedstrijden, zowel nationaal als internationaal, uitzenden zowel online als op televisie, zal de sport toegankelijker maken. Er moet ook gewerkt worden aan de atmosfeer van wedstrijden, er is de perceptie dat het publiek stil moet zijn. Hieraan kan gewerkt door de speaker het publiek te laten aanmoedigen. Er kan ook gewerkt worden met licht en muziek om de wedstrijd aantrekkelijker te maken. Daarnaast zouden andere formats van wedstrijden kunnen helpen. Teamwedstrijden trekken vaak meer volk aan omdat mensen vaker voor teams supporteren dan voor individuen. Ook een ander scoresysteem waarbij bijvoorbeeld in duels wordt gewerkt kan een oplossing zijn, met zo'n systeem kan een publiek beter volgen wie aan het winnen is. Zo'n wedstrijden blijken een groot succes te zijn in het buitenland, enkele voorbeelden hiervan zijn de Bundesliga in Duitsland, Top 12 in Frankrijk, Serie A in Italië en de NCAA in de Verenigde Staten.

Er kan dus heel wat gedaan worden om de populariteit ven de sport op te krikken. De technologie van Fujitsu is zeker een deel van de oplossing, maar er kunnen daarnaast ook nog andere dingen gedaan worden om de sport naar een hoger niveau te tillen.

# Woord vooraf

Deze masterproef is het sluitstuk van mijn vierjarige opleiding Handelswetenschappen aan de Universiteit Gent. Ik had niet gedacht dat ik de turnsport, mijn hobby en passie, had kunnen combineren met mijn studies.
Een nieuwe technologie die volop nog in ontwikkeling zal voor een revolutie zorgen in de turnsport, die vergeleken met andere sporten misschien wat achteraan hinkte op technologisch vlak. Ik hoop dat deze studie de ogen zal openen van federaties en clubs en ze overtuigt dat er iets kan gedaan worden aan de populariteit van de sport, maar daaraan moet natuurlijk gewerkt worden. Ik ben daarom erg fier op het werk dat ik geleverd heb, ik heb er veel tijd, werk en passie in gestoken. Ik ben ervan overtuigd dat dit onderzoek van waarde kan zijn voor zowel federaties als clubs om te groeien.

Deze masterproef werd geschreven van september 2019 tot en met mei 2020. Midden maart werd België getroffen door het Coronavirus en de crisis die daarop volgde. Gelukkig heeft deze situatie mijn onderzoek niet beïnvloedt, de interviews waren zo goed als afgerond net voordat het land in lockdown ging.

Ik heb deze thesis niet alleen kunnen schrijven. Ten eerste wil ik mijn promotor Willem Standaert bedanken die geloofde in mijn onderwerp en mij zeer goed heeft begeleid tijdens deze studie. Ik wil ook alle personen bedanken die ik heb mogen interviewen, zonder hen was deze studie niet mogelijk geweest. Ik wil hierbij ook de Gymnastiekfederatie bedanken die mij heeft toegelaten om zijn topsportgymnasten, trainers en juryleden te mogen interviewen. Ik wil ook mijn vrienden en familie bedanken die mij hebben gesteund tijdens het schrijven van dit werk.

Céline Decoster 2 Juni 2020

# Table of Contents

# Abbreviations

AI – Artificial Intelligence

COP - Code Of Points

D – Difficulty

E – Execution

EC – Executive Committee

HR – Human Resources

JEP – Judge Evaluation Panel

FIFA – Fédération Internationale de Football Association

FIG – Fédération Internationale de Gymnastique (International Gymnastics Federation)

IRCOS – Instant Replay and Control System

ML – Machine Learning

RTD – Reconstructed Track Device

VAR – Video Assistant Referee

WAG – Women's Artistic Gymnastics

# Figures and tables

## Pictures



## Figures

# Tables

# 1. Introduction

## 1.1 Problem statement

*"I think it would have more credibility if it had some objective component that the audience can understand, if done right, it would give the audience, media and sponsors a new level of confidence in the accuracy of results* (Radnofsky, 2019)*".* – Mike Jacky, former official of the FIG.

The sport of gymnastics has been plagued by different judging scandals in its history. Even nowadays with the Instant Replay and Control System (IRCOS), the replay video system, there are still some controversial scorings at big international competitions. But this could shortly come to an end, as Artificial Intelligence (AI)-based judgment systems promise to be bias-free. In particular, the Japanese technology company Fujitsu and the Fédération Internationale de Gymnastique (FIG) are collaborating to develop a new judging support system, combining human judgment with AI. "The Fujitsu technology can measure height, body angles or the number of degrees by which a gymnast splits her legs, in three dimensions and from any direction" (Radnofsky, 2019). The FIG gave green light for its official debut at the 2019 Artistic Gymnastics World Championships for four apparatus (Fujitsu, 2019). The goal is to use the technology more extensively at the now postponed 2020 Tokyo Olympic Games. FIG and Fujitsu believe that such a system would not only improve the performance evaluation in terms of fairness and transparency, but could also help gymnasts train more effectively and on top of that, also make the sport more attractive for fans to follow, and therefore for media and sponsors to get involved.

Sports that are judged by a judging panel, such as gymnastics and figure skating, have had to deal with judging scandals, these often involve bias and cheating from the judges. To avoid that, it is important to objectify the way these sports performances are evaluated. Several sport governing bodies have attempted to increase the accuracy of officiating decisions by implementing new technologies in their sports (Kerr, 2016). Swimming and running have introduced the stopwatch and photo-finishes, soccer uses goal-line technology to determine whether a goal is validated or not. However, the criteria to evaluate sports performance in running, swimming and soccer are straightforward. The decision-making factors can be measured objectively, the time needed to complete a certain distance, or whether or not a ball crosses a goal line. This is not the case for sports where the performance is evaluated by a judging panel. These are subjective evaluations and are perceived to be unreliable in sports, so technology is often introduced to assist with the provision of reliable, empirical data (Kerr, 2016).
In sports such as ice hockey, American football, and soccer, Video-Assisted Refereeing (VAR) has been introduced (Kerr, 2016). This involves the ability to watch a fragment of action repeatedly or in slow-motion to be able to make more accurate decisions. Such video replay systems have also been introduced in artistic gymnastics, the sport we focus on in this thesis. It simply enables judges to replay the routine, or parts of it, in slow-motion and high-definition to confirm exactly which movements the gymnast made (Kerr, 2016).

This research project aims to better understand the effects the implementation of emerging technologies based on AI in sports can have, for multiple stakeholders. For this case study, I will focus on the new

AI-based technology that Fujitsu is developing for gymnastics. The use of AI could remove bias in the sport, which would not only be great for the fairness for the athletes, but also the audience, media, and sponsors. While three types of stakeholders can benefit from such technology (athletes and coaches, the judges, and the spectators), I will primarily focus on the spectators. I will investigate if judging technologies can make gymnastics more understandable, transparent, and fair, and therefore more popular for spectators to watch. I will also investigate if the technology could help the performances of gymnasts, and what that could mean for the popularity of the sport through better performances and more media attention. This is very relevant from a marketing point of view, as the sport suffers from a lack of interest in-between Olympic years, as opposed to soccer and tennis for example.

## 1.2 Research Question

This case study answers the following research question (RQ).

| What do stakeholders think of the implementation of a Human + AI judging system in gymnastics? |
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## 1.3 Relevance of the research

The judging scandals the sport of gymnastics has had to deal with are often the consequence of human bias in performance evaluation. Human bias can be related to the nationality of the gymnasts, order of the gymnasts' performance, or their reputation (Findlay & Ste-Marie, 2004). One of the biggest judging controversies in recent history was at the 2004 Olympic Games in Athens, at that time gymnastics was scored by the perfect 10 scoring system[1]. The American Paul Hamm was awarded the gold medal in the all-around final, while South Korean Yang Tae-young got the bronze medal. The latter encountered a judging error that docked him 0.1 of a point for his parallel bars routine, which was enough to cost him the gold medal (Rutherford, 2016). The governing body, the FIG, has acknowledged the error but refused to change the results. This scandal has damaged the credibility of the FIG and the sport as a whole. It is worth to mention that two years after the controversy, the perfect 10 scoring system has been replaced by an open-ended scoring system. The new system has implemented a few rules in order to eliminate bias in judging. First of all, out of six execution scores given by six different judges, the lowest and the highest score are dropped in an attempt to eliminate bias (Duong, 2008). Another attempt to remove bias is to not have judges from the same nationality in one judging panel. For event finals the rule is even more strict, the nationalities of the gymnasts competing cannot coincide with the nationalities of the judges. Results of a study done by Duong (2008) at the 2008 Olympic Games show a statistically significant level of bias among many judges. Duong (2008), suggests that some of the bias could be explained by the corruption levels of the judges' nations.

[1] Each routine was given a start value that was determined by the elements included in the routine, as well as added value for connections and other bonuses. "The actual score was the total of credit given for the routine minus deductions for execution. The highest score possible for each was determined by the start value, with a maximum of 10 points" (USAgym, sd).

Another problem regarding gymnastics is the duration of the competitions. This affects the three stakeholder groups mentioned in the introduction. For the athletes, the duration of a competition is very long. The longer the competition, the more risks for injuries. For athletes, a World championships last approximately two weeks. This means fourteen days – or even more because delegations come several days early to accommodate to time differences – of competitions and training in training halls that are not equipped with soft landing surfaces. When training, gymnasts don't often land on hard surfaces to protect the ankles and legs. The fact that competitions are that long, increases the risk of injuries.

The length of a competition also affects the performance of judges, the longer the competition, the more difficult it is for judges to keep a high level of concentration, and evaluate every gymnast to the same standard. The goal for judges is to speed up delays in scoring, ensure that every nuance of an athlete's performance is recorded and that controversial decisions in scoring are avoided (Logothetis, 2017). A qualifications day can last up to 12 hours, and the same judging panels need to see all the gymnasts to limit inconsistencies in judging. It is known in the gymnastics community that gymnasts who compete in the first subdivisions of a qualifying day are judged more strictly than gymnasts who compete in subdivisions towards the end of the day. It has cost some gymnasts competing in the early subdivisions to gain a spot in a final or even a medal. However, no studies have been done to prove this.

The fact that gymnastics competitions take that long also affects the broadcasting schedules. It is very expensive for a TV channel to broadcast a gymnastics competition because of its duration. Gymnastics is one of the most-watched sports during the Olympic Games (Das, 2019), but in between those four years, the popularity decreases strongly. In non-Olympic years it's very expensive for TV channels because the sport is not watched that much, and it takes air time for sports that attract more viewers such as soccer, cycling, and tennis. And, if a competition takes that much time, people might get bored, or simply do not have time to watch a whole competition. This is why not a lot of countries buy the broadcasting rights for big international competitions, such as the world championships.

Reducing the length of a gymnastics competition, and enhancing the way of broadcasting could increase the broadcasting of gymnastics, which can lead to a sport that is popular all year long. The introduction of AI could help reduce the duration of a competition by assisting the judges.

Another reason why gymnastics might not be as popular is because for an outsider it is difficult to understand how the sport works. What is a good routine and what is a bad one? When is a skill well executed and when not? How does the scoring system work? What is difficult and what is not? If an audience is better informed and can answer the questions here above, it will appreciate the sport and the gymnasts' work better, which can lead to an enlargement of the fanbase. AI could be used to make the audience better understand the sport and be more involved by giving more information and numbers.

In conclusion, it is important for the sport to be more objective, this will lead to people that will be less skeptical about the scores, and more interested in the sport. New technologies such as AI can be implemented in different domains of a sport to make progress.

In the next part of this paper, the literature and studies on topics about sports marketing, bias, technology, AI, and fairness will be discussed. These theories will be used as a foundation for my research. After this chapter, the qualitative research that has been done and the results will be discussed. The last chapter concludes the takeaways of this study.

# 2. Literature

## 2.1 Sports marketing

From a sports consumer perspective, several factors affect the attitude and behavior of consumers toward relationship formation with a brand or entity. These factors are commitment, involvement, trust, and shared values (Kahle & Bee, 2006). All these factors could be reinforced with the introduction of technology. Research has shown that fans become more engaged as data is shared (Cortsen & Rascher, 2018). Technologies can provide such data. Data is a well-suited application for marketability purposes in the football industry, such as fan engagement, promotional efforts, and mediated content.
The sports industry is booming, fans are not passively following sports anymore, they are involved with it all the time thanks to the development of interactive content, social media, and connected venues (Masters, 2019). Some sports such as soccer for example have understood these developments and gain a lot of profit because of it, on the other hand, other sports missed the boat and have lost potential revenues. "Sports organizations cannot survive without the mass exposure of the media, and the media needs sports to satisfy the growing consumer demand for this type of entertainment. Today's consumers want to be engaged, demanding up-to-the-minute platforms that provide exclusive content, statistics, and interactive forums based upon live, on the field, action" (Shank & Lyberger, 2014, p34). Data is a big factor to increase fan engagement, "the more data is available on what's happening on a playing field or a court, it really enhances the fan experience" (Socolow, 2017).
According to Masters (2019), fan engagement is important for multiple reasons. First, it attracts new followers and retains current fans. These fans spend a lot of money on tickets, experiences, and merchandise. A second reason is because of the declining in-person attendance of sports competitions (Masters, 2019). This is due to ticket and parking prices, and technology that creates a superior at-home experience for fans which leads to fans preferring to watch a competition at home. A third reason is staying ahead of competitors, this can be done through implementing new technologies (Masters, 2019). As the sports industry is growing, gymnastics should keep track of it and evolve to the next level to keep up with the big sports in terms of popularity and to make more money off it. Therefore technologies could help to get more people involved and to enhance the marketing of the sport.

The next sections will go more in-depth on the topics of bias, fairness and transparency, and technology, which can all influence the fan engagement of gymnastics.

## 2.2 Bias in judging

Different studies have been done to examine the performance of judges in a sports context. Plessner and Schallies (2005) revealed that even experienced gymnastics judges are significantly influenced by their viewing position while judging a cross on rings. A study evaluating the judges' performance in rhythmic gymnastics found that even international-level judges performed at a mediocre 40% error detection level (Flessas, et al., 2015). Another study done in rhythmic gymnastics concluded that there are both objective and subjective factors negatively affecting the behavior of judges (V.V, 2013). Objective factors include intense competition schedule, fatigue, memory, attention, and competition rules. Subjective factors include the ratio of judges to their gymnasts (or team) or the opposing team,

the lack of interest in the performance, the composition of the judging panel, and the influence of authority and popularity of the sportswomen (V.V, 2013).
These studies show that judging errors are often not intentional to let a favorite win. Often factors that are own to humans, such as fatigue and declining concentration, or context-related factors such as viewing position or composition of the judging panel influence the scoring accuracy of judges.

Table 1 shows the different types of biases in a judging context, identified from the literature (Plessner & Schallies, 2005; Flessas, et al, 2015; V.V, 2013; Boen, van Hoye, Vanden Auweele, et al., 2008).

*Table 1 – Different types of biases*

| **Bias** | **Description** |
|---|---|
| Reputation bias | A judge awards a higher score to an athlete (s)he knows. |
| International bias | A judge awards a higher score to an athlete representing their own country. |
| Serial position bias / Within-team order bias | A judge awards a higher score to an athlete later in the rotation. |
| Sequential bias / Memory-influenced bias | A judge is influenced by specific prior performances of another athlete. |
| Conformity bias | A judge adapts its marks to those of the other judges of the panel. |

Judges often score unfairly because of biases unconsciously influencing their scores. Different types of bias in sports can be determined, judging errors can be a result of nationalistic bias, expectations of success, and genuine mistakes (Kerr, 2016). Findlay and Ste-Marie (2004) studied reputation bias in figure skating. They found evidence for the notion that sports performance evaluation can be influenced by non-performance factors. Ordinal rankings were found to be higher when skaters were known by the judges as compared to when they were unknown. Findlay and Ste-Marie (2004) claim that a reputation bias does exist during the evaluation phase of sports performance in any sport that is evaluated by a judging panel. The researchers determined four other types of bias in judging sports such as figure skating and gymnastics. The first type is international bias. In the past, judges have been shown to award higher scores to athletes representing their own country.

Plessner (1999) observed a serial position bias: a competitor performing and evaluated last gets better marks than when performing first. This is related to the second type of bias which Findlay and Ste-Marie (2004) determined, the within-team order bias. Coaches are aware of this type of bias and use it in their line-up strategy. The strategy consists of placing the strongest athletes later in the within-team order or rotation. Judges are found to give higher marks to a gymnastics performance if it was evaluated at the end of a rotation order than if that same performance had been evaluated early in the rotation (Findlay & Ste-Marie, 2004).
Sequential bias was found in a study observing the 2004 Olympic games, the evaluation of a gymnast is likely more generous than expected if the preceding gymnast performed well (Damisch, Mussweiler, & Plessner, 2006). This is related to the third type of bias Findlay and Ste-Marie (2004) determined,

which is the memory-influenced bias. The perceptual judgments of gymnastics judges are influenced by specific prior performances of a gymnastics element. This demonstrates the effect of prior knowledge on a judgment task.
Boen, van Hoye, Vanden Auweele et al. (2008) found a conformity bias: open feedback (i.e. the judges can see and/or hear the scores given by the other judges on their panel after each performance) causes judges to adapt their marks to those of the other judges of the panel. A non-technological solution could be that judges are unaware of the scores the other judges on their panel gave.

Heiniger and Mercier (2018) developed a statistical engine in collaboration with the FIG and Longines. The engine is named the Judge Evaluation Program (JEP), it was made to analyze the performance of gymnastics judges during and after major competitions. One of the objectives was to detect bias and outright cheating. In their study, they found that judges are more precise when judging the best athletes than when judging mediocre ones (Heiniger & Mercier, Judging the Judges: Evaluating the Performance of International Gymnastics Judges, 2018). In a second study, Heiniger and Mercier (2018) studied national bias of international gymnastics judges during the 2013-2016 Olympic cycle. They defined two types of national bias: judges can favor athletes of the same nationality, or judges penalize athletes from competing nationalities (Heiniger & Mercier, National Bias of International Gymnastics Judges during the 2013–2016 Olympic Cycle, 2018). An alarming result is that the national bias of some judges is two to three times larger than all the sources of errors of an average judge. Luckily, this has led to only one modified podium at an international competition, due to the efforts of the FIG to avoid same-nationality judges in finals.

The fairness literature suggests that by eliminating bias and making the process more transparent, positive outcomes for multiple stakeholders can be expected (Heiniger & Mercier, 2018; Boen, van Hoyer, Vanden Auweele, Feyse & Smits, 2008; Damisch, Mussweiler, & Plessner, 2006; Findlay & Ste-Marie, 2004; Plessner H, 1999). For this purpose, the use of a system that combines human and AI decision making could be of relevance.

The next section will talk about different technologies that are being used in sports nowadays.

## 2.3 Use of technology

The use of technology in sports is not new, it has been applied in different areas of the sports industry. For TV broadcasting, performance analysis, for assisting in sports performance, or for referee/judging decision making for example. Kirkbride (2013, p140) states, "levels of competition become ever closer, the margins separating performances are decreasing, often necessitating the use of technology to adjudicate some occurrences." This is why new technologies for decision making in sports are needed to make more accurate decisions.

Table 2 shows an overview of different technologies used in different sports.

*Table 2 – Different technologies used in different sports*

| **Technology** | **Sports** |
|---|---|
| Video Replay | Gymnastics, soccer, ice hockey, American football, basketball, baseball, cricket, fencing |
| Line technology (goal) | Soccer, ice hockey |
| Timing systems | Swimming, running, cycling |
| Motion capture technology | Ski jumping, snowboarding |
| HawkEye | Tennis, Cricket |

In the area of decision-making stop-watches, photo-finishes, and touchpads are commonly used in sports such as swimming and running to determine the rankings. These technologies obtain empirical data, then convert the data into a score without human intervention (Kerr, 2016), they have proven their indispensability in these sports. They are so accurate that a result cannot be doubted by athletes, trainers, or the audience. These technologies lead to greater transparency in the results of sports.

Video replay is another common technology that has been introduced in quite a lot of sports such as basketball, baseball, hockey, fencing, etc. However, the International Football Association (FIFA) has only introduced it in 2018, at the World Cup (Harris, 2018). When there is a doubt of any kind, video replay can often help to eliminate that doubt. Gymnastics has its own video replay system, known as IRCOS (Instant Reply and Control System). It allows judges to replay a routine, or a part of it, to confirm exactly which movements a gymnast made in case of an inquiry. This is a hybrid system that utilizes both humans and technology. The FIG has acknowledged the flaws of human judging, for this reason, it allows athletes to fill in an inquiry against their score when they do not agree with the difficulty score the judges awarded them based on the routine they showed. Based on the video replay, judges re-evaluate the routine and adapt, if needed, the score the gymnast deserves.

Hawk-Eye is a technology frequently used in cricket and tennis and is based on Reconstructed Track Device or RTD. It uses visible-light television cameras to follow the path of the ball and a procedure to filter the pixels in each frame (Kerr, 2016). This technology also improves the sport-media connection of a competition. During a broadcast, the commentators can discuss the zone of doubt when the reconstruction is shown. This leads to spectators having a greater understanding of why some decisions are made. So technology has proven to be an added value for the audience.

However, sports with subjective judgments, such as gymnastics, figure skating, or diving, use other technologies to help determine the rankings. Subjective judgments are perceived as unreliable, as Kerr (2019, p116) states, "In sport, the accuracy of the results of a game or competition is important for the sport to be deemed valid, but in many cases in sport, humans cannot always provide reliable results." As proven in many studies about the evaluation of judges, humans cannot give results that are accurate for 100%. This is why technology is often introduced to assist and add an objective aspect to the judgments.

Ski jumping is also a sport that involves some subjective judging. This sport already uses motion capture technology to detect errors. It is a fairly good technology for this sport as ski jumping has a clearly defined motion structure, which facilitates data segmentation (Brock, Lee, & Oghi, 2017). The biggest stumbling block of using motion capture in other sports is that sensor data captured under field conditions suffer from noise, bias, or missing data that impair the data quality (Brock et al., 2017). Up to now, motion capture has been the mainstream technology for recording human and object movement in the form of digital data. This technology requires attaching markers to the body of the athlete which can bother an athlete while playing or performing (Fujiwara & Ito, 2018). New technologies are required to be able to measure human movement without encumbering its performances.

However, there is also some strong opposition to using objective technology to judge any component of a score (Harding, Toohey, Martin, Hahn, & James, 2008). That opposition is two-folded, judges are afraid to be replaced by technology, but it also has something to do with the values such as freedom, individuality and aesthetic focus (Harding, Lock, & Toohey, sd). People are attached to these values and don't want them to disappear because of technology.
So, there are definitely a lot of positive sides to introducing technology in the evaluation of sports, such as making the results more accurate and adding value for spectators. But there are also some negative aspects related to it. Next, a new technology using AI which is being developed to assist judges in evaluating gymnastics routines will be discussed.

Fujitsu is "the leading Japanese information and communication technology (ICT) company, offering a full range of technology products, solutions, and services" (Fujistu, sd). The company developed a system that measures human motions without having to put markers on the athletes that can be very encumbering, especially in gymnastics. Fujitsu's technology uses 3D laser sensors (See picture 1) developed for automobiles, combined with joint position recognition software that is developed by the company for rehabilitation. The joint recognition module uses deep learning technology. "This 3D sensing technology oscillates many lasers on a scale of about 2 million points per second, detects the reflected light, and calculates the distance to the target object (point cloud). It then recognizes the joint positions from this shape, calculates hands and feet positions, bending of joints, etc., and finally compares those results with model data of human movement in a database to derive differences in movement" (Fujiwara & Ito, 2018, p67).


*Picture 1 – Fujitsu's 3D sensing device, consisting of a camera, a Lidar pulse transmitter and a receiver* (Sarazen, 2019).

Figure 1 is a visual representation of the overview of the technology.

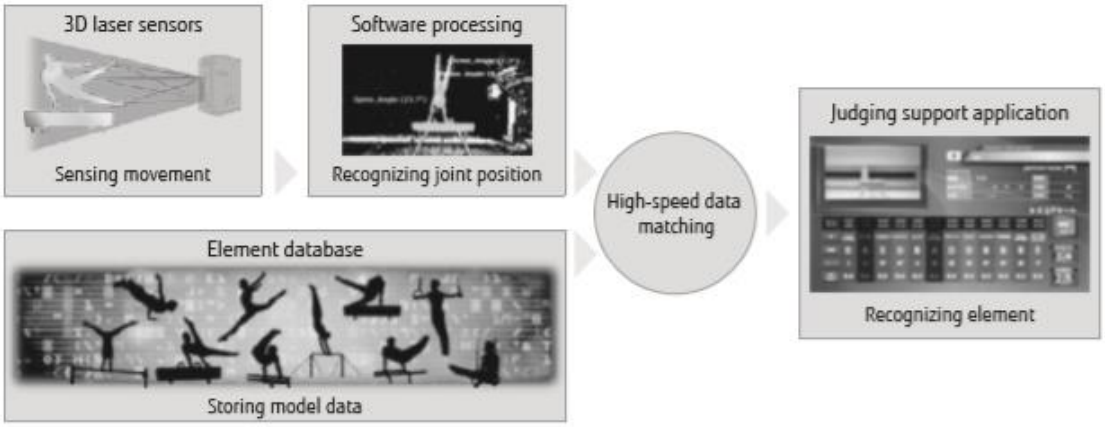
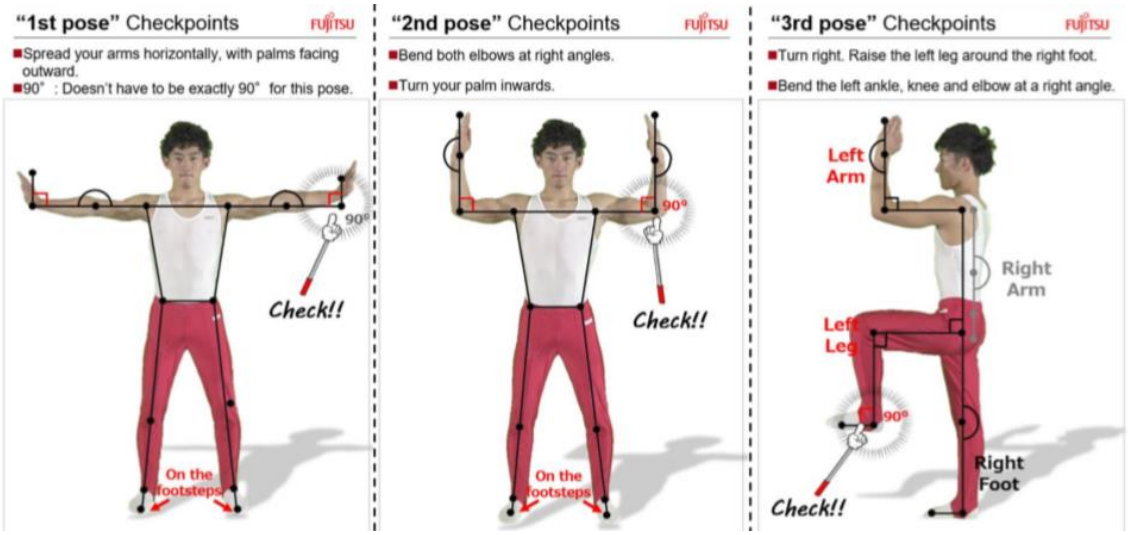



*Figure 1 – Overview of 3D sensing technology (Fujiwara & Ito, 2018, p68)*

The key modules of Fujitsu's judging support system are movement sensing, joint position recognition, and a database of gymnastics skill elements. The key to this system is a high-speed matching of captured data with previously stored data (Sarazen, 2019).

To build the database for the AI, Fujitsu obtains athletes' performance data from competitions. They did so, amongst others, at the 2019 World Artistic Gymnastics Championships in Stuttgart, Germany. After the podium training, each gymnast was requested to go to the 'Body Dimension Measurement', to be filmed by a 3D camera in 3 simple poses to help calibrate the system (see picture 2). According to a Fujitsu official, more than 90 percent of the athletes had agreed to participate in the full-body scan. Those who didn't were evaluated using standardized body dimensions, but officials concede that determining the position of athletes' joints is more precise, given the variation in athletes' muscle thickness if the computer has individual data (Keh, 2019). According to Watanabe (2019), the president of the FIG, during the competition, all the performances of each gymnast were recorded to be used as a secondary system to help settle inquiries or blocked scores at the championships. The system supports both the difficulty and execution scoring of gymnastics skills, but in the first phase, it will solely be used to determine difficulty values of routines at competitions.




*Picture 2 – Body Dimension Measurement* (Fujitsu Limited, 2019)

Figure 2 shows the process of the skeleton recognition technology. It derives the positions of the human body by the positions of the joints from the depth images obtained by the 3D laser sensor. This process requires the output of joint positions and joint angles as 3D data to provide judges with real-time assistance. To make use of machine learning, a learning phase that creates prediction models is needed. This requires the creation of depth images from previously obtained movements with joint coordinates to prepare a training set for machine learning (Sasaki, Masui, & Tezuka, 2018). Then follows the fitting process, these joint coordinates are used as initial values to apply a human to the point cloud corresponding to the depth images.

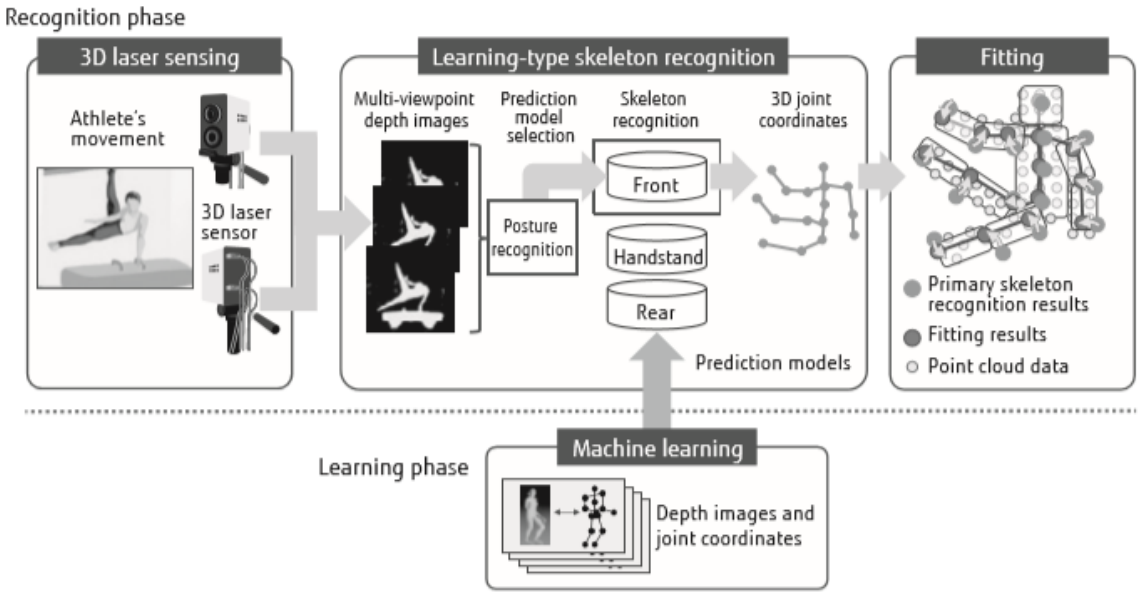



*Figure 2 – Overview of high-speed, high-accuracy skeleton recognition technology (Sasaki, Masui, & Tezuka, 2018, p13)*

So the system uses AI solely to recognize the different positions a gymnast performs. There is no intelligence used to go from the skeleton position to a score, this is done by the automated implementation of the rules.

Figure 3 shows the digitalization of elements so that the AI can recognize elements performed based on the body positions of gymnasts, and match them to optimal performance, as defined by the FIG. The issue of judging in gymnastics is that the current scoring rules, written in the Code of Points (CoP), are described by vague expressions and athlete illustrations. Expressions such as 'straight' or 'slightly bending' can be interpreted differently by different judges, which is a problem to come up with an objective score. In this form, the rules cannot be implemented into a judging support system application. For this reason, the system features a skeleton model having 18 joints, the skeleton assigns a number to each joint. The example below states that no points are deducted when the hip angle (the angle of the line consisting joints 4, 0 and 11) and the knee angle (the angle of the line connecting joints 0, 11 and 12) are greater than 170 degrees (Fujiwara & Ito, 2018). Such scoring rules need to be created for all elements in the CoP.

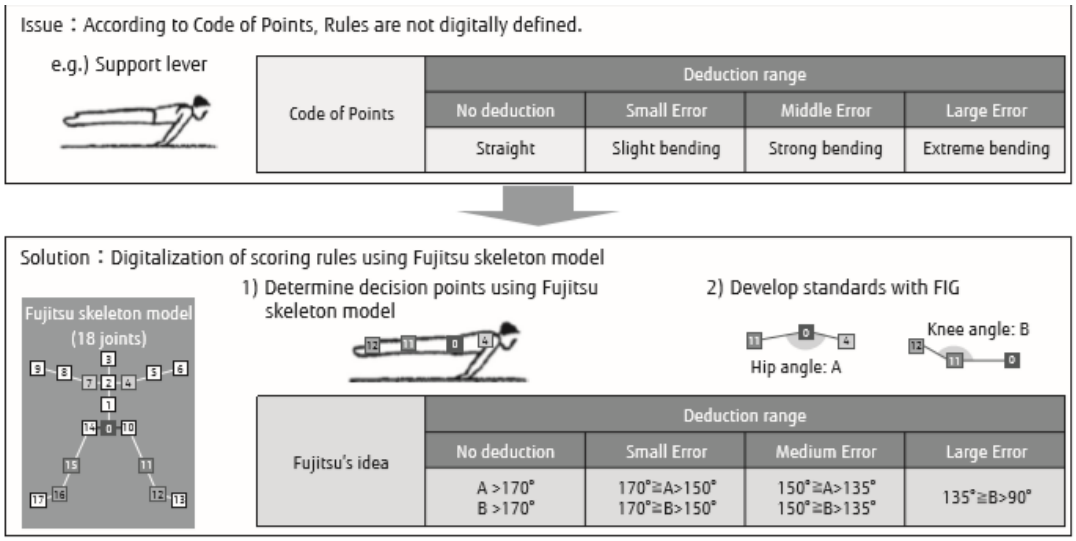



*Figure 3 – Digitization of elements (Fujiwara & Ito, 2018, p69)*

Fujitsu's system aims to overcome human limitations so that judging will become more fair and accurate for all the athletes. More about the technology and its features will be discussed later in this paper.

## 2.4 AI versus humans

Rational decision making has been defined by Herbert Simon as the process of selecting the alternative that is expected to result in the most preferred outcome (Shrestha, Ben-Menahem, & von Krogh, 2019). AI refers to technology that performs "activities that we associate with human thinking, activities such as decision-making, problem-solving, learning" (Bellman, 1978). AI has introduced itself in the decision-making process, "AI — and, in particular, machine learning algorithms — enables the creation of new information and predictions from data (provided that the future can be fairly well predicted by existing data)" (Shresta et al., 2019, p67). A lot of experts in different professions already rely on AI-based algorithms when making important decisions.

Shrestha et al. (2019) compared human and AI-based decision making. They did so by comparing their characteristics along with five key decision-making conditions. The first one is the specificity of the search space, AI-based decision making needs to be done in a well-specified decision search space while humans can do it in a more loosely decision search space. The second condition is the interpretability of the decision-making process and outcome, AI can sometimes be difficult to interpret the decision process and outcomes, while humans can usually provide reasoning for their decisions. The third key condition is the size of the alternative set, AI can make decisions based on large alternative sets, humans have a more limited capacity. Next is the decision-making speed, AI has a fast decision-making process, humans are comparatively slow. The last key condition is the replicability of outcomes. The outcomes of the AI decision-making process are highly replicable while the replicability of human decision making is not, because of inter- and intra-individual factors (Shresta et al., 2019). In the research design section, these five key decision-making conditions are applied in a gymnastics judging context.

However, the use of AI has some pitfalls, there is increasing evidence that AI-based decision making may introduce or amplify different biases and challenges for upholding fairness, accountability,

transparency, and, consequently, trust in AI-based decisions (Shresta et al., 2019). It will be a challenge to develop a structure that minimizes these risks. Shrestha et al. (2019) developed a framework that comprises three structural categories: full human to AI delegation, hybrid — human-to-AI and AI-to-human — sequential decision making, and aggregated human-AI decision making.

In the full human to AI delegation structure, there is no human intervention, AI-based algorithms make the full decisions. However human decision-makers are responsible for the decisions made by AI. This structure can be particularly useful in scenarios where the decision search space is specific and restricted. For this particular reason, full delegation cannot be applied in a gymnastics judging context. The decision search space is not specific enough for the artistry value of a gymnastics routine. Artistry is too subjective to be judged by AI solely. Thus, full delegation cannot be used for gymnastics judging as long as the artistry component is not objectified. In addition, studies have shown that machine-learning algorithms can acquire and replicate implicit human biases toward race and gender from the online textual data they use to derive insights and inform their decisions (Shresta et al., 2019). This is specifically what should be avoided while judging different gymnasts of different races and with different body types.

The second category is the hybrid sequential decision making. Both humans and AI-based algorithms sequentially make decisions such that the output of one decision-maker provides the input to the other (Shresta et al., 2019). The researchers define two types of hybrid structures: algorithmic decisions as input to human decision making and human decisions as input to algorithmic decision making. The former consists of two phases. In the first phase, it is the AI that makes a decision based on the initial set of alternatives and delivers a subset of suitable alternatives to the human decision-makers. In the second phase, these human decision-makers select from these alternatives (Shresta et al., 2019). The second hybrid system uses human decisions as input for algorithmic decision making. Here, human-decision makers first select a small set of alternatives from a larger pool and deliver this onto the AI algorithms for evaluation and selection of the best alternatives (Shresta et al., 2019). In this case, it would be the judges that first select what skills a gymnast has performed, and then let AI control it. This is a less reliable and efficient manner of judging as the influence of bias cannot be eliminated because of humans making the first decision.

The last decision-making structure from is the aggregated human-AI decision-making structure. "In this structure, decisions — or aspects thereof — are first allocated to human and AI decision-makers based on their respective strengths. Human and AI-based decisions are then aggregated into a collective decision using an aggregation rule such as majority voting or (weighted) averaging" (Shrestha et al., 2019, p76). In a gymnastics context, AI algorithms would be put in to judge the well-defined skills a gymnast performs, while human judges only judge the artistry value of a routine. The final score would be a combination of the two parties. This aggregated structure implies that human decision-makers cannot control the decision made by AI algorithms. This decision-making structure would be ideal for gymnastics judging as long as AI cannot evaluate subjective factors such as artistry. However, in this case, the AI algorithms cannot have any flaws and should be 100 percent accurate to use it in a competition. For this reason, at the moment it would be more reliable to take advantage of a hybrid system, as humans can intervene in case of errors made by AI.

Seidel, Lindberg, Berente, & Lyytinen (2019, p52) developed the Triple-loop human-machine learning model, it "occurs whenever humans and autonomous computational tools interact in generating design outcomes". As the name reveals it, it is a hybrid decision-making model involving both humans and machines in the process. This model learns us that humans and machines interact with each other to generate design outcomes (the first loop) (Seidel et al., 2019). The interaction happening is the black box of AI, it is not known how the AI has generated the outcomes. The model also shows that both human learning and machine learning is happening (second loop). So both types of intelligence improve each other to generate better outcomes.

Dellerman, et al (2019) developed a taxonomy of design knowledge for hybrid intelligence systems. In a hybrid human-AI system, the strengths of human intelligence and AI are used complementarily to behave more intelligently than each of the two could be in separation (Dellerman, et al., 2019). In the research design section that taxonomy is applied to the subject of this paper.

So a hybrid decision-making model seems to be the most fitting for a gymnastics judging technology.

## 2.5 Procedural fairness in the decision-making process and outcome acceptance

The concepts of fairness and justice have been used interchangeably in the literature, it is the quality of making judgments that are free from discrimination. Justice models suggest that people react to authorities by assessing whether they are acting fairly. Two types of justice models can be distinguished: distributive and procedural justice (Tyler & Lind, 1992). Distributive justice emphasizes fairness of outcomes and allocation patterns. People evaluate authorities by comparing the outcomes they receive to the outcomes others receive and use this comparison to determine whether the outcome distribution accords with the accepted principles of fairness (Tyler & Lind, 1992). Procedural justice refers to the fairness of the procedures through which decisions are made or rules are applied (Tyler & Lind, 1992). Researchers van den Bos, Vermunt, and Wilke (1997) revealed that variables related to procedural justice explain more variance in judgments of fairness than variables related to distributive justice. The process leading to the formation of fairness judgments may be more strongly affected by procedures than by outcomes (van den Bos et al., 1997).

Procedural fairness is concerned with the fair process effect (Folger, Rosenfield, Grove, & Corkan, 1979). In their book, Folger and Copranzano (1998, p32) defined this as "the more someone considers a process to be fair, the more tolerant that person is about the consequences of the process, such as adversely unfair outcomes that a decision-making process creates when it governs the distribution of outcomes." Perceived procedural fairness positively affects how people react to outcomes (van den Bos, Wilke, Lind & Vermunt, 1998), and is needed when information about an authority's trustworthiness is lacking (van den Bos, Wilke & Lind, 1998). When people do not know if the authority can be trusted or not, they interpret the outcome based on the perceived procedural fairness. Leventhal, Karuza, and Fry (1980) used six characteristics to describe whether procedures are fair: consistency, unbiased suppression, representativeness, correctability, accuracy, and ethicality. In the research design section, these characteristics will be applied to the gymnastics context.

A study about procedural justice in negotiation revealed that increased levels of procedural fairness lead to more acceptance of negotiated agreements (Hollander-Blumoff & Tyler, 2008). High procedural fairness decreases the positive relationship between outcome favourability and people's support for the system (Brockner, et al., 2003). Thus those who perceive a procedure as fair, are willing to accept a decision and support the system. This is why it is important to have a fair decision-making process.

In a review of the procedural justice literature, Konovsky (2000) refers to both objective and subjective procedural fairness. Objective procedural justice is the factual justice that leads to subjective justice perceptions. Konovsky (2000, p492) defines subjective justice as "the capacity of an objective procedure to enhance fairness judgments." He also attributes three components of the justice experience to subjective procedural fairness perceptions. These are the cognitive, affective, and behavioral components. The first component refers to "the calculations made by a perceiver regarding the objective fairness of a decision" (Konovsky, 2000, p492). For example, perceivers may compare the way they were actually treated to the way they expected to be treated. The second component is the affective one, it refers to the emotional reactions to unfair procedures (Tyler, 1994). However little research has been done on the emotional reactions to unfair procedures. The behavioral component may be the most interesting one for the topic of this paper.
A study about organizational transparency and employee trust from Rawlins (2008) revealed that the relationship between trust and transparency is highly correlated. The researcher also revealed that employees feel a greater sense of commitment, and show engagement behaviors when they feel treated fairly by their employees. To increase trust, organizations must be more open and transparent with their communication (Rawlins, 2008). Another study revealed that fairness perceptions lead to behavior and attitudes from the perceivers. In an organizational context, it has been demonstrated that procedurally fair treatment has resulted in increased job satisfaction, organizational commitment, and organizational citizenship behavior (Konovsky, 2000). In contrast, procedurally unfair treatment has led to negative behaviors.

### 2.5.1 Fairness in sports

In a study about the current uses of technologies to assist referee decision-making processes in sports, Leveaux (2010) studied how these technologies can provide a platform for facilitating correct decisions in sports. That study examined the following sports using technologies: rugby, football, cricket, tennis, and taekwondo. The study shows that there is a need for technologies to reduce the incidence of controversial decisions and lead to fairer competition. The introduction of technologies has improved the playing environment and assisted the referee to promote fair play. In some sports the use of technology has eradicated illegal and foul play, "this promotes a more attractive sport for both the spectators and the players due to the contest being determined without illegal play or tactics, but rather on the athletic ability and performance of the participants" (Leveaux R., 2010, p6). However, the researcher also found that technology should only be an aid of a referee to enhance better decision making. Technology cannot be used solely for decision-making because it cannot interpret and assess the myriad of situations in a competition (Leveaux R., 2010). This was the case in 2010, and is still

relevant, almost a decade later. Rhue (2019) revealed that AI isn't reliable for soft and non-quantifiable goals. It is thus clear that AI is not ready yet to be used for more complex situations.
In another study by Leveaux (2012), the specific case of the use of technology for taekwondo at the 2012 Olympics was assessed. In the past, the sport has struggled to be attractive for spectators and with providing transparency in the decision making of the judges. To address these struggles, the sport has embraced technological advances, and it has paid off. The technology has increased the transparency of scoring because of the minimal human intervention in the scoring process. The study concluded that technologies greatly improved the correctness of the decisions, which contributed to a more attractive competition (Leveaux R., 2012).
Besley (2010) reveals that fairness variables are significantly related to the respondent's willingness to accept a decision-making process. Thus, those who believe a decision is fair will accept the decision (Besley, 2010). It is important to create perceived fairness among the audience to make them accept the process of a decision. Another study affirmed that a transparent version of a system was better understood than a non-transparent one (Cramer, et al., 2008). Cramer et al. (2008) also found that offering explanations had a significant effect on user understanding and acceptance of recommendations. Hence, if the procedures are transparent, people think judges evaluate fairly, people trust that the score judges come up with is correct. This suggests that if the audience knows the decision-making process of judges is reliable, it will lead to fewer score controversies and a better reputation of the sport.

Applying these theories to the field of study of this paper, it can be concluded that perceived procedurally fair judgment can lead to increased satisfaction of gymnasts, coaches, and the audience, and an increase of fan engagement. But even more importantly, the perception of procedurally unfair judgment can lead to reverse behaviors. This demonstrates the importance of procedural justice in judging has on fan engagement.

### 2.5.2 AI and fairness

Employing AI in procedures was found to uphold two main components of procedural fairness: Consistency and transparency (Robert, Pierce, Marquis, Kim, & Alahmad, 2020). These two components are what is lacking in judging in gymnastics. Introducing AI could make sure that the same procedure is used every time, and that the procedure is transparent. This could be a great evolution.
A study about AI and fairness in a Human Resources (HR) context from van den Broek, Sergeeva, and Huysman (2019) revealed that new notions of fairness need to be considered when implementing AI. Beforehand, it is important to define what the different interpretations of fairness are, including the importance of accuracy of the information and the consistency of decision-making (van den Broek et al., 2019). Because AI is trained on existing data, the resulting models reflect the societal biases around given attributes due to the spillover effect (Rhue, 2019). Also, the fact that AI learns from human behavior over time leads to decisions and actions by an AI system that might not be fair to the employees (Robert et al., 2020). The input data must be bias-free to develop an AI model that has no bias either. Only when all the different interpretations of fairness are considered, these can be taken into account when developing AI technology to prevent these biases in the technology. "The literature in algorithmic bias

agrees that artificial intelligence will likely reflect a societal bias for sensitive topics and/or protected attributes like race and gender" (Rhue, 2019, p3). The study of Rzepka and Berger (2018) confirms this as well, AI systems are attributed to typical human behavioral, cognitive, and affective characteristics, including the biases.

Rhue (2019) revealed that AI algorithms need to have human oversight, they excel at pattern-finding, but not necessarily at the soft and non-quantifiable goals such as fairness. The researcher found that the introduction of AI scores induces bias due to the anchoring effect (decision-makers are sensitive to the initial starting point in their predictions (Tversky & Kahneman, 1974)) for the subjective measures. For example, if an AI judging system would be used to judge a gymnastics routine, judges would be biased on the subjective measures such as artistry. No bias has been found for objective measures. It is important to quantify the subjective topics into numerical data if AI needs to interpret these subjective topics.

Rzepka and Berger (2018) revealed that the transparency of the AI system's decisions or actions significantly influences users' behavior. Xu, Centefelli, and Benbasat (2014) revealed that increasing a system's transparency positively affects a user's perceptions of recommendation systems. Judges will be more positive toward the system if it is more transparent. Transparency in the decision-making process also leads to higher perceptions of informativeness and enjoyment, and thereby also better evaluations of decision quality and system acceptance (Xi et al., 2014). Thus, a more transparent judging system will possibly lead to more enjoyment of watching the sport and less scoring controversies.

## 2.6 Research Questions

In this case study, I aim to investigate the implications of the Human + AI system from Fujitsu for the three types of stakeholders in gymnastics: judges, gymnasts and coaches, and spectators/fans, in addition to the non-gymnastics fans.

Figures 4 and 5 guide the development of our research questions.

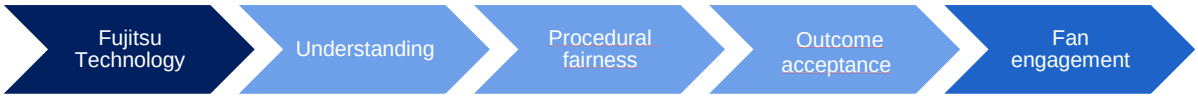



*Figure 4 – Steps to greater fan engagement – The fans' path*

Figure 4 describes the steps that could lead to a greater fan engagement through the application for fans. The technology offers additional information to the audience, at home, or in the arena, this way spectators have a better understanding of how the scoring works. This will also make that the judging decision-making process would be perceived as fair because they understand it, it would make it more trustworthy for the audience. This could then lead to more outcome acceptance resulting in more engagement.

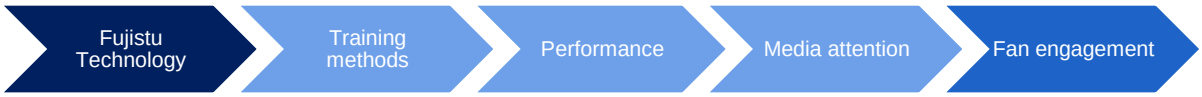



*Figure 5 – Steps to greater fan engagement – The gymnasts/coaches' path*

Figure 5 describes the steps that could lead to a greater fan engagement through the application for the gymnasts and coaches. The implementation of the technology will allow coaches to develop better training methods, this could lead to better-trained gymnasts who can have better performances, because of a competitive advantage, on the international level. Better performances can result in more media attention, as well as more sponsorships and investments. That extra attention will ultimately lead to more engagement in the sport.

For judges, it will be interesting to know how their task changes and how they feel about this. Do they fear their job is at stake? Do they think it is a good idea to have a technology they can rely upon?

> **RQ 1:** How do judges welcome the arrival of a helping tool?

For spectators, they sometimes have difficulty to understand the scoring. The technology can add some measured numbers to stadium viewing experiences and broadcasts, making it more understandable and attractive to watch. What do the stakeholders think of that additional information, and how could it influence procedural fairness?

> **RQ 2**: How does the use of a hybrid judging system lead to more fan engagement, through a better understanding of the decision, procedural fairness, and outcome acceptance (see process in Figure 4)?

The system could potentially help to develop better training methods. What influence could the development of training methods have on fan engagement?

> **RQ 3**: How does the use of a hybrid judging system lead to more fan engagement, through better training methods, better performance, and media attention (see process in Figure 5)?

Finally, there are other factors, besides the technology, that could influence fan engagement.

> **RQ 4**: What are the factors that make competitions unattractive to watch? How can organizations create a better atmosphere at competitions? How can other rules or other competition formats attract more people?

In the next chapter, the methodology of this qualitative research will be discussed.

# 3. Methodology

## 3.1 Study description

In this research, the perception of what the three stakeholder groups think of Fujitsu's technology will be investigated. How will the implementation of the technology affect them? Do they like the idea or not? What could be the advantages and disadvantages for them? How could the technology affect fan engagement?

Before elaborating on the study, the way gymnastics is judged will be explained. Gymnasts perform a mix of skills, these can be acrobatic and dance skills. The CoP is a rulebook that contains the table of elements, in this section, each skill gets a difficulty value assigned going from A (worth 0.1 points) to J (worth 1 point). The score is made up of two separate scores, the Difficulty (D-) and the Execution (E-) score. The D-score is built from each skill the gymnast performs. The value of each skill performed successfully is added to the D-score. The E-score, on the other hand, starts at 10 points. Judges then take deductions for technique, artistry, and errors. Small errors get small deductions (0.1 for example), big errors such as fall get big deductions (1 point for example). The difficulty and execution scores are added together and make the final score of the gymnast. Bias can occur in both the E- and D-score, as it is fairly easy for a judge to misinterpret a skill, or to take more or fewer deductions for a skill.

## 3.2 Research design

In this section, the models and theories described in the literature review section are applied to the context of this research.

### 3.2.1 AI versus humans

AI technology can be combined with human decision making in different constellations (Shrestha et al., 2019). The researcher's five key decision-making conditions are applied to identify how AI and human input can be combined in an optimal way, in Table 3.

*Table 3 – The five key decision-making conditions in a gymnastics judging context*

| **Decision-making conditions** | **In a gymnastics judging context** |
|---|---|
| Specificity of the search space | The value and the criteria of each acrobatic or dance skill a gymnast performs are quite vaguely defined in the CoP. The artistry component is also defined in the CoP, but in an even more subjective way, different interpretations are possible. |
| Interpretability of the decision-making process and outcome | The outcome here is a score composed of a D- and E-score. The decision-making process is the process of evaluating a routine to come up with a score. |
| Size of the alternative set | The total number of different possible routines. There are hundreds of different skills and different combinations possible. So the size of alternative sets is really big. |

| | |
|---|---|
| Decision-making speed | The time it takes for a judging panel to come up with a score after a gymnast finished his/her routine. |
| Replicability of outcomes | The same routine should be judged identically by two different judging panels. The same routine should be judged identically by the same judging panel at a different time. |

Regarding the specificity of the search space, everything but the artistry component can be interpreted by AI. The vaguely explained skills can be objectified to be used for AI, while the artistry component is, at this moment, too subjective to consider. That is because the decision space is not specified enough. So both humans and AI are needed to evaluate a gymnastics routine. The second condition is the interpretability of the decision-making process and outcome, the process and the outcome of the judging must be interpretable to ensure fairness toward the athletes. So AI will have to have a high level of interpretability to be implemented. The size of the alternative set in this context is very big as there are so many different skills and combinations possible to form a routine. Here AI is in a better place as it has more capacity to make decisions based on large alternative sets than humans. This is also the case for the decision-making speed, to limit the duration of a gymnastics competition, coming up with a score fast is appreciated, AI outperforms humans in this case. The last key condition is the replicability of outcomes. The same gymnastics routine must be scored identically, so high replicability is needed, therefore AI is advantaged compared to humans.

As to condition the size of the problem, speed, and replicability, AI is expected to outperform humans for the context at hand. However, for specifying the search space and interpreting the process and outcome, humans are expected to outperform AI. Hence, by combining AI (first) with human (second) input, it is likely to result in better outcomes than the use of either one in separation (Dellerman, et al., 2019). Not surprisingly, this is how Fujitsu's judging system is designed.

Dellerman, et al (2019) developed a taxonomy of design knowledge for hybrid intelligence systems. What follows is an application of that taxonomy on the subject of this paper, judging in gymnastics. Task characteristics are the first dimension, the task of the hybrid intelligence here is the judging of a routine. It involves two types of tasks, the recognition of the skills that are performed, and the prediction of the score. The second dimension is the learning paradigm. In this context, we can talk about hybrid augmentation where both humans and machines learn from each other. Machines learn through human judges generating a score that the machine learns to imitate. The amount of human input needs to be collective, to prevent errors and biases of individual humans, which is very important. On the other hand, humans learn from the machine feedback, which are predictions of scores. The interpretability of hybrid intelligence is crucial to prevent biases, achieve reliability and robustness, ensure causality of the learning, debugging the learner if necessary, and for creating trust especially in the context of AI safety (Dellerman, et al., 2019).

When using a hybrid system with algorithmic decisions as input to human decision making to a gymnastics context, it is the AI that selects the skills a gymnast has performed first, then it is the human judges that control if these match with what the human panel had judged. Similar to the delegation

structure, the decision search space has to be specific and restricted. So the artistry cannot be judged by AI, but in this hybrid system, human judges can fill this gap.

AI systems are known to have a black box, it is not known how AI generates the output. In the case of a gymnastics judging AI system, there is no black box as the process of seeing a gymnast performing a routine, and generating the score for that routine is determined. In this case, we talk about explainable AI instead of black-box AI. Explainable AI has the advantages of being accountable (we know how an automated decision is reached and can trace the path of reasoning if needed) and auditable (we can review processes, test, and refine them more accurately, and predict and prevent future failures or gaps) (Ditto, 2019). Explainable AI is much more appropriate for the gymnastics judging context than black-box AI.

In marketing, procedural fairness has been found to alleviate a trade-off between price pressure and relationship quality (Muylle & Standaert, 2016). In gymnastics, conflicting outcomes could be fast decisions and accurate decisions. AI abolishes that trade-off, the decisions will be done faster and more accurately, this is a win-win situation for all three stakeholders (the gymnasts and trainers, the judges, and the audience).

### 3.2.2 Procedural fairness in the decision-making process and outcome acceptance

Rhue (2019) stated that it is important to define all aspects of fairness before implementing AI to avoid biases in technology as it is based on human thinking. In the context of gymnastics judging it is very important to think about all the factors that make a score fair. It is not enough to consider the nationality of the gymnast, but judges can also be biased about the skin color or body type of a gymnast while judging. The six characteristics to describe whether procedures are fair can be applied to the context of this research (Leventhal et al., 1980).

*Table 4 – The six characteristics describing whether procedures are fair (Leventhal, Karuza & Fry, 1980)*

| **Characteristic** | **Procedural fairness in gymnastics judging** |
|---|---|
| Consistency | All gymnasts being judged have to be judged consistently, the judges have to apply the CoP consistently. |
| Unbiased suppression | No differences in judging can be made for gymnasts from different nationalities, or for gymnasts who have a reputation. |
| Representativeness | The judging procedure must integrate the interests of the gymnasts and coaches. |
| Correctability | If there are some questions about the way a gymnast was judged, there should be room for correction. |
| Accuracy | The judges have to evaluate accurately based on the CoP. |
| Ethicality | No differences in judging can be made for gymnasts with different body types, or different racial backgrounds. |

In the current judging situation, the characteristics consistency, unbiased suppression, accuracy, and ethicality are not met. This is because of the subjectivity of human judges, this is a limitation own to humans that makes that they cannot always be consistent and accurate. Also, the ethicality and

unbiased suppression characteristics are not met because of judges being unconsciously influenced by bias, body type, and ethnicity. The only characteristics that are met are representativeness and correctability. The Executive Committee (EC) of the FIG has the duty to develop and approve rules and guidelines. This EC is composed of members integrating the interests of the gymnasts and coaches in the judging procedures (Fédération Internationale de Gymnastique, 2019). The FIG also has procedures in place if there are some questions about a judgment. Federations can fill an inquiry if they think they weren't judged correctly, then the routine is judged again, and the score is corrected if needed. However this is only for the D-score, the E-score cannot be reviewed and corrected. So, the current judging situation doesn't meet the characteristics of being procedurally fair. The qualitative research will investigate if those characteristics will be met with the new judging system as a helping tool.
The elimination of bias could be related to making the decision-process of judges more transparent. If it is more transparent, biases will be reduced. An increase in transparency will lead to an increase in the credibility of the judges, which will be appreciated by gymnasts, coaches, and the audience.

### 3.2.3 Fujitsu

Fujitsu is aware of the technological developments in sports and is anticipating with their new technology. The FIG and Fujitsu issued a press release in which they reveal the three features aimed to be developed through the new technology (Fujitsu, 2018). In addition to supporting judges in making decisions, and assisting athletes with training, it can also help the audience to better understand and enjoy gymnastics. Especially that last feature can be important from a marketing perspective. Spectators and viewers can have a difficult time understanding the performed elements and their judging criteria. To help the viewers, the system can append quantitative indicators such as height and stability to competition streaming services, to guide the audience to a better appreciation of the sport (Sarazen, 2019). Fujitsu is convinced that providing more information to the audience through technology will increase the attractiveness and popularity of the sport. They will to that by offering TV and online broadcasting content, while providing display boards and smartphone systems for visitors at competitions. They will also maintain a database and implement digital marketing to expand the fanbase of gymnastics and improve profitability (Fujitsu, 2018). In an article in the Washington Post, a Fujitsu official stated that "the technology also could add entertainment value to TV broadcasts and phone apps. One day, it could represent potential revenue for gymnasts themselves, who will be able to market and monetize their data" (Clarck, 2019). Gymnasts could sell their data for a video game for example.
Fujitsu claims that this technology can give the audience, media, and sponsors a new level of confidence in the accuracy of results. The company also claims that its judging system will shorten the gymnastics competitions because 'robot judges' are faster in judging than human judges. Shortening the time will make competitions more enjoyable to watch. And it will make it possible to fit it all in a TV broadcast timeframe of approximately two hours instead of a broadcast of three and a half to four hours. This will result in more programs being broadcasted (Fujiwara & Ito, 2018).
The technology will be used to enhance the viewing experience and draw attention to sporting events. This is a very interesting marketing feature, it could be a game-changer for gymnastics, which suffers from a lack of interest in-between Olympic years. Next, the methodology of the research will be discussed.

## 3.3 Research methodology

### 3.3.1 Interviewees

A qualitative research has been performed to answer the research questions. Interviews have been done with the three groups of stakeholders (the gymnasts and trainers, the judges, and the fans) as well as with non-fans of gymnastics. The goal of the interviews is to obtain opinions from all stakeholders about the hybrid system, with an emphasis on the development of fan engagement.

For this case study, 30 persons were interviewed. The six interviewed gymnasts are current or former international elite gymnasts. The six interviewed coaches are current elite coaches, while the five interviewed judges are all international judges. The seven interviewed fans are people that like to watch gymnastics, have performed it at a low level, or have some background in the sport but cannot be identified as gymnasts, judges, or coaches of an international level. The six interviewed non-fans are people that would never watch gymnastics out of their selves, or have never watched a gymnastics competition, and know little to nothing about gymnastics.

### 3.3.2 Procedure

30 interviews were taken, 25 out of them were done orally, 5 of them were written interviews. Before starting the interview a video from Fujitsu's YouTube channel (Fujitsu, 2019) explaining Fujitsu's technology was shown as an introduction. The video was shown until 1 minute 55 seconds. The interviewees were then asked some open questions about the topic.

The following general questions were asked to every interviewee:

- What is your first reaction after seeing this video and being introduced to the technology?
- What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?
- Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?
- Are there other things that might be (more) important to help the sport move forward? Are there things that are not important and could be left behind? Why?

In case it wasn't mentioned yet the following question was asked:

- How could the sport ameliorate in terms of fan engagement?

To the trainers and gymnasts these specific question was asked:

- What impact could this technology have on training methods?
- What do you think fans will think of this technology? Will it help attract new fans to the sport?
- What do you think judges will think of this technology?

To the judges this specific question was asked:

- What do you think fans will think of this technology? Will it help attract new fans to the sport?

To the fans and non-fans this specific question was asked, if not mentioned yet:

- Do you think this technology will induce more fans watching/following the sport?

The interviews were taken in the mother language of the interviewee which was either French or Dutch, the interviewer has both French and Dutch as her mother tongues. All the interviews were translated, as literally as possible to English and written out for further analysis (See Appendix 2). The interview transcripts were coded into different nodes using NVivo. These nodes were made based on the literature review and the research questions (See Appendix 3).

## 3.4 Results & interpretation

### **RQ 1:** How do judges welcome the arrival of a helping tool?

Fujitsu's technology is being developed as a judging tool to reduce some issues that come with judging gymnastics. But what do judges think of the arrival of such a tool?

Most of the judges embrace the technology as a helping tool because they acknowledge that they make some errors and that the system could help them to judge more efficiently and correctly.

> *"I like the system, it will bring some more clarity about what is straight or not, we are just humans, we make errors. (..) I have to say that as a judge, I am not always sure if I am right. When I am with two or three other judges, then one out of 15, or one out of 20, I am wrong. If I would be alone, I wouldn't be corrected, and such a system can do that."* (Judge 4)
>
> *"The advantage is that it will be way more correct. As judges, clearly, we try to be as correct as possible but I know that sometimes we make mistakes. (…) If it's used as a tool to help, then it's a positive thing. For example, if the machine can do the D score, and there would be more judges for the E score, then that could be interesting."* (Judge 5)

Another reason why judges sometimes cannot evaluate as accurately is because of their viewing position.

> *"For example at worlds in Doha I was a D1 judge on floor, when the gymnasts perform on the other side of you, she is 15 meters away from us, then you don't have sight of her feet. (…) With this system, it will always be correct (…).* (Judge 3)
>
> *"If they use it only for the D score that would be very positive because as a judge we see something from certain angles, it's not always in function of how the gymnast moves. For example, if she performs a thing in one way or another, we see it better or not."* (Judge 5)

Judge 3 mentions that it will be a question of time until every judge sees the advantages of the system and doesn't feel threatened. This is why it is better to introduce it for the D score only.

> *"I think it's necessary that they use the technology only for the D, and that judges do the E score. (…) I think that in a first instance judges will react in a negative way because they will feel threatened. (…) It's something that has to mature, (…). And then hopefully everyone will see the advantages of the system, and then they will be more open towards the system."* (Judge 3)

Some judges don't like the system at all, they are afraid that the technology will take over completely and that they will lose their jobs.

> *"And also, will they still need us then? We study, we invest quite some time in it, we are asked a lot, we go to different places. If they start to only use some judges together with the technology, we won't be needed anymore while having been invested in it for years."* (Judge 2)

So most judges will embrace the system if it is used as a helping tool, but none of them want the technology to take over completely, that is one step too far.

## **RQ 2:** How does the use of a hybrid judging system lead to more fan engagement, through better understanding of decision, procedural fairness, and outcome acceptance?

The first step in this process is a better understanding. How can the technology lead to a better understanding of the scoring system to the audience?

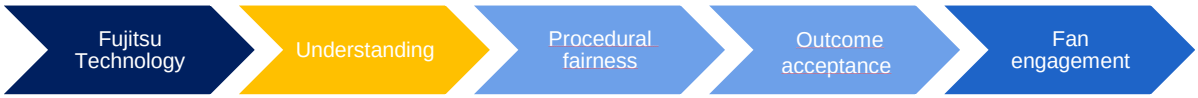



*Figure 4a – Steps to greater fan engagement – The fans' path –Understanding*

Most of the interviewed fans think that the additional information is an added value. The fans that know something about the judging will like to see details such as the values of skills and the deductions.

> *"For the fans, I think it would be very interesting for them."* (Fan 1)
>
> *"A positive is that thanks to the technologically, we will understand a lot more."* (Fan 3)
>
> *"(…) this information is nice to know. (…) I am a fan of getting extra information on a second screen, or that the extra information is showed on the broadcast on television, on the side of the screen."* (Fan 4)

Fans that don't have that knowledge will appreciate the information to know a little more about how the scores are built.

> *"I like that they show how long he holds that cross and how high she went on floor. When you see that on television, it goes so fast that you don't know if it was straight or not. So it's helpful.*

*And also to know if it was a double or a triple twist because I don't always see that. (…) For me as a fan it's an added value to know these metrics, I think it's interesting."* (Fan 6)

So additional information is certainly good, but it shouldn't be too much either.

*"If you have too much information, you will lose, it just has to be there to explain, or to show in slow motion why a gymnast got deductions. (…) Too much information will kill the information."* (Fan 3)

*"On the other hand, they don't have to suffocate the audience with information. Nowadays the majority of spectators watch gymnastics as a spectacle. There should be room left for this aspect of the sport. It isn't all about if there was a goal made or if the ball is in or out."* (Fan 5)

In contrary, some stakeholders think that spectators don't really care about having that additional information, also a fan thinks that this extra information is redundant.

*"For people that know nothing about it, that information is redundant. Then everything should be explained and it will more look like a documentary than a competition, then there is no fun anymore."* (Gymnast 2)

*"(..), but what they say about the spectators, I think they don't care about seeing angles and heights."* (Fan 2)

So based on these answers we could say that most of the fans would appreciate additional information being given while watching gymnastics. Other fans probably won't cherish that feature. It depends on whether persons are interested in such information or not.

The next step in the process is the perceived procedural fairness. How can the availability of additional information lead to more perceived procedural fairness?

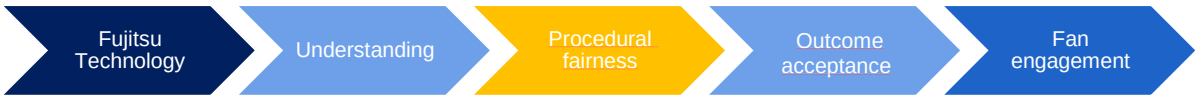



*Figure 4b – Steps to greater fan engagement – The fans' path – Procedural fairness*

Most of the interviewees mentioned that the implementation of the system would make the judging more objective and more clear, and it would also lead to less discussion about the judging. This would eventually lead to a fair evaluation of the gymnasts.

*"The advantage is that everyone is treated the same way, which is very important."* (Gymnast 2)

*"An advantage is probably that it will be more objective, and there will be less discussion."* (Gymnast 5)

*"For the spectators, it could help them to have a better appreciation and to understand what they see, and also that there will be less cheating, that it will be more rational, everyone will be judged the same way."* (Non-fan 3)

*"The biggest advantage is that it will be the correct person that wins and that there won't be that many discussions anymore, it will be the same for everyone."* (Non-fan 6)

The respondents indicated that the hybrid judging system would benefit the perception of procedural fairness because of equal treatment, reducing discussion, and correct evaluation.

Another important characteristic of procedural fairness is the existence of bias in the judging process. How can the implementation of the technology lead to less bias in judging?

A lot of interviewees from the different stakeholder groups mentioned that there still is some bias in judging. Three types of biases could be identified in the interviews: nationality, reputation, and sequential bias. Even judges admitted that they are influenced by bias.

Nationality bias.

*"Because they get more advantaged by judges, and with the technology that won't happen anymore. (..) Like we also see that, when we go to an international competition in The Netherlands, we know that they will help us. When they see a Belgian or a Dutch in comparison to another nationality, they will judge more harshly for them, and just normal for the Belgian or Dutch."* (Gymnast 3)

*"I assume that there is some preferential treatment within the judges, judges that have to judge someone of their own country or judges that are friends and give each other benefits. If it's used, everyone will be treated the same way."* (non-fan 6)

Reputation bias.

*"And now with that technology, there won't be such a distinction. They aren't especially less strict because of their reputation, but also yes they are. The judges expect them to be good so they are more bound to overlook such things (..)."* (Gymnast 3)

*"Nowadays we notice that the top performers are judged less harshly than sub performers because they have a name and they are popular. Sometimes if an American had done a routine, it would have gotten a better score than if I would have done that same routine. Because judges know that they are from a big country."* (Gymnast 4)

*"(..) but as a judge, you notice that when there is a gymnast with a name, like Nina Derwael for example, you know that she is good. And I think, even though you don't want to do it,*

*unconsciously you judge less strictly. Because of the name, I think it plays a role unconsciously, with the technology you don't have that problem."* (Judge 1)

Sequential bias.

*"It's very approximate for us, often it depends on the first vault you have seen. Or sometimes you see a great vault and take almost no deductions, but then you see an even better vault, even higher and further, and consequently, you also take almost no deductions, but there is no difference between the two."* (Judge 5)

*"It's the same for either context of judging, when the first starts, it's always the most difficult to evaluate because if someone better comes after, you have to be able to give a better score. With this technology, everyone will be judged the same, the draw of when you are being evaluated won't influence the way you are judged."* (Non-fan 6)

Some judges even showed some bias while answering.

*"For example, there are judges that think Simone Biles' choreography is very static, well I don't have that opinion, I think that she's a phenomenon she's exceptional, yes she may have some flexed feet, or her choreography doesn't correspond very well, but it was made for her physique, and for me, she's a bomb, I love it. Before, there were gymnasts that didn't do a lot of difficulty and also had that type of choreography on the floor, and I didn't like it. But because Simone is a phenomenon it's different."* (Judge 2)

One coach explained why some judges could be biased by the reputation of gymnasts.

*"Judges are not paid for their jobs, they do that as a hobby because they are also fans of gymnastics. They can be a fan of a specific gymnast and therefore be subconsciously less harsh. They admire some gymnasts. I don't think it happens un purpose, but the fact that they look up to some gymnasts surely influences them. (…) I don't blame the judges, because I think it primarily happens unconsciously. The technology will certainly avoid those influences."* (Coach 4)

So the problem would be that judges are fans of gymnastics and can be a fan of gymnasts and thus unconsciously favor them in their judging.

Cheating is another characteristic that makes the judging process could be perceived as less fair. How could the use of the technology have an influence on cheating in judging?

The respondents acknowledged that sometimes there can still be some cheating.

*"Sometimes it's like countries have agreed to help each other even if it's about little things such as a bent knee or a handstand that they still give, but it can be the difference between a medal*

*or not. So this is what I really like about the technology, and I think that some judges will think "oops, we won't have it under control anymore"."* (Gymnast 1)

*"And I think it will be great for the judging, that it can be neutral because let's be honest, judges evaluate, they are humans, they aren't always impartial."* (Fan 3)

*"[Does that 'cheating' happen a lot?] Constantly. Consciously as well as unconsciously."* (Judge 4)

The respondents are convinced that the introduction of the technology in judging will limit bias and cheating. On the other hand, most of that occurs in the E-score, while with the hybrid system, humans will still evaluate the E-score, so it will not completely solve the problem.

*"But if for now they only use it for the D score, the problem of subjectivity will remain, because it especially happens in E score."* (Gymnast 3)

*"But on the other side I don't think that the problem is in the D, it's more in the E. If there are cheaters within the judges, (…), that happens more in the E-score than in the D-score."* (Judge 4)

Gymnasts and coaches are the ones that are affected the most with the judging, what is their opinion about the use of a hybrid system for the judging?

Almost all coaches and gymnasts mentioned that the technology would make the judging fairer because currently, that is not always the case.

*"Positive is that everything will be more based on reality and there will be less favoritism between the judges themselves because, in my eyes, the images don't lie (…)."* (Gymnast 1)

*"But it's an advantage that with that for example they can't favor the Americans, over Hungary, because it's a computer and it can't think about it. I think that sometimes it still happens at competitions."* (Gymnast 2)

*"For the judging, it's going to be more objective, (…). Even if they have just have it as a support when something was missed, we have that to justify that they missed something, so I think that is great."* (Coach 5)

*"Well, the advantage is that it's accurate, if the foot is straight it will be straight, and if it's flexed it will be flexed, and that machine will see that of course. So it will see more details, it will be more accurate than the naked eye."* (Coach 6)

One gymnast said it would be great that the judging will be more objective, but on the other hand, subjectivity is a part of the sport and that would be taken away.

> *"An advantage is probably that it will be more objective, and there will be less discussion. (…) It's not a big problem, because that is how our sport is, there are always disagreements and there is a bias towards some countries, so in itself, it's not abnormal, so that technology would make it fairer. And it would be less subjective, but in the end, it's a jury sport, so it would take away the basis of gymnastics."* (Gymnast 5)

There are also some constraints about whether the system could evaluate execution and artistry at some point. Especially for Women's Artistic Gymnastics (WAG), the respondents think that human judges will always have to evaluate artistry.

> *"Because yes the technology can probably measure the amplitude of the legs perfectly, but the gracefulness and such, if you are on the rhythm of the floor music, I cannot really imagine that technology can do that."* (Gymnast 1)
>
> *"On the other hand, there is still the human aspect, especially on floor exercise. There it's important that you bring over emotion to the judges and the audience in your choreography. A computer cannot perceive and evaluate that."* (Gymnast 6)
>
> *"Because there will always be human judges needed for the artistic part, I imagine that the machine cannot evaluate that, maybe in the long term yes."* (Judge 5)

For these reasons, most of the respondents agree for the technology to judge the Difficulty but want human judges to evaluate the Execution, which involves the artistry.

> *"I agree with fewer judges because there are too many of them, but for now I think judges for the E-score are still needed, and maybe in the future, I would agree with no more judges at all."* (Gymnast 5)
>
> *"I think that for the judges, at the actual state, it should be a supporting tool and it cannot replace everything."* (Coach 5)
>
> *"For example, if the machine can do the D-score, and there would be more judges for the E-score, then that could be interesting."* (Judge 5)
>
> *"For the judges I am not really for it, to calculate the D-score yes, but not for calculating the E-score, I think that the judges need to do that."* (Fan 2)

A lot of gymnasts and coaches point out that the evaluation of the system could be too harsh, it would be too precise. But on the other hand, it will be harsh for everyone.

> *"I think that the technology will look at every little detail, now it's possible that the eyes of the judges can't see everything, such as a poorer executed movement, but if it happens like that for*

*every gymnast, then it's like that for everyone because the image says is. Which in fact will be good because there won't be a discussion about it anymore."* (Gymnast 1)

*"But the disadvantage is for the gymnasts themselves, for example at high bar you do something almost to handstand, a judge will say "okay it's a handstand", they won't be too strict. While a machine will see it's 97°, they will take one tenth."* (Gymnast 3)

*"The negative thing is that every little error will be detected."* (Coach 2)

On the other hand, it could motivate some to get even better.

*"Yes and no for gymnasts, they will get penalized more, but it's also good because it will motivate us to keep pushing to get better and to make fewer errors."* (Gymnast 3)

Some of them say that the FIG will have to adapt its CoP to this new system to improve the judging.

*"And also, the CoP is written in such a matter with degrees and such, maybe they will also have to write it differently. (…) So they could work with margins, but then you diminish the sense of using computers. For example, the machine could say that you can deviate from ten degrees."* (Coach 4)

*"But what I'm afraid of is that the system may have another way of thinking than judges always had. (…) If we consider something as straight, in the video for example there was someone who performed a cross on rings, we as judges would consider it too low, but the system would consider it as perfectly straight. So the federation will have to be clear on what they want."* (Judge 4)

There could also be a problem with executing techniques, which techniques will be validated by the system, and which won't?

*"Every gymnast has another body type and different techniques. (…). But especially in handstands, everyone has different ways to position itself in a handstand, and sometimes you can be in a handstand, without being correctly in a handstand but it would still be credited, you can have your shoulders and feet well positioned, but the rest of the body isn't because of a hollowed back, in that case, will the technology credit the handstand or not? So they will have to take that into account."* (Judge 5)

*"Who and how will they determine which method is the most appropriate for a movement? In the case of twists, there exist multiple techniques. Why would they chose one technique above another and don't we risk to robotize movements?"* (Fan 5)

Another constraint of some gymnasts and coaches is what influence the different body types of gymnasts will have on the judgment of the Execution score. What body type will the technology see as the 'ideal', and will other body types be disfavored because they don't have that 'perfect body type'?

> *"Another negative point is that the morphology of some gymnasts can favor them. Today with human judges it already happens indirectly. A tall and slim gymnast, such as Nina Derwael, is more appealing to watch, especially on bars, than a small and stocky build gymnast. But this is very subjective because every judge has its own opinion, and normally it cannot influence the score."* (Coach 1)
>
> *"But for the E-score I have some questions, every athlete is different, has a different body type. And gymnasts who haven't the right body type will probably be punished for that, which is not fair I think."* (Gymnast 5)
>
> *"But I have questions about the difference in body types and the different body positions of everyone. (…) I wonder if the technology would consider that or not, and if that will disadvantage some gymnasts."* (Judge 5)

After procedural fairness comes outcome acceptance. How can the fact that stakeholders perceive the judging as (more) fair, lead to more outcome acceptance of the scores?

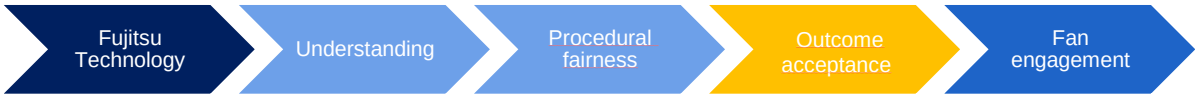



*Figure 4c – Steps to greater fan engagement – The fans' path – Outcome acceptance*

Gymnasts admitted to questioning the scores they get sometimes. With the system, the gymnasts will have more faith in the score they get because they believe the technology will be more accurate. They think the technology can be used as a tool to justify the scores.

> *"I really think that it will enhance the sport by making it more objective and that there will be less discussion like "is the angle good or not, is the turn fully completed or not?", these are things that you can perfectly see with the technology which I think is great."* (Gymnast 1)
>
> *"If the technology is used as a tool to help them when there is a discussion for example, then that is absolutely an advantage. Because then there will be no more discussion between the judges who saw what."* (Gymnast 2)
>
> *"You can't compare any competition in scores, at one competition you perform a good routine without a fall and get 11.6. The next competition you perform a routine with a fall and get 12.4, this is kind of ridiculous."* (Gymnast 6)

So the gymnasts think that the use of the system will affect their outcome acceptance positively, as they would have more trust in the procedure of Fujitsu's system, than that of the human judges.

The fans are also a stakeholder group that are involved with outcome acceptance. In general, some fans pay attention to scores, and some don't. For the fans paying attention to scores, a part of them have questioned scores in the past, others haven't. Especially for people new to the sport, they don't always know why a certain routine scored better than another they preferred, the technology could lead to more acceptance of the scores for them.

> *"Because when you see something as a layman you think something is great but then you see a bad score and they are like "I don't understand this, why would I watch it?" so this could make them understand more why that score was given."* (Gymnast 5)
>
> *"And also from outsiders, there is discussion if the judging happens correctly, "you can give the points you want". (…) Sometimes it's like "she has won by 1 tenth, if you had put one more mark, she wouldn't have won", this is some critique we get a lot. The technology could reduce those discussions, people will have more faith in it, and it will be more clear so that everyone will agree that the technology is correct. And what the technology has decided is correct and cannot be doubted."* (Judge 1)
>
> *"Sometimes when I watch gymnastics on tv and I watch the scores, I don't always agree, even though I don't know a lot about the judging. A judge will always turn a blind eye if it's a gymnast from its own country competing. So that technology will help with that."* (Fan 6)
>
> *"You can justify the scores on the television screen. People will be less skeptical about the scoring. Now a lot of people know or think that big countries such as Russia, the USA, and China get advantaged, and that could be a reason why people don't watch because they are like "we already know who is going to win, these countries always win"."* (Non-fan 6)

On the other hand, one judge states that most of the spectators don't have problems regarding outcome acceptance.

> *"I don't think that people watching gymnastics have an unfair feeling, they know so little about the scoring that they are not asking themselves if a score is fair or not. Maybe that the 10% knowers in the arena will remark something is wrong with the judging. Maybe in some extreme cases such as in Athens 2004 with Paul Hamm, there the judges were right, but the audience just has a completely wrong impression."* (Judge 4)

The last step in the process is fan engagement. How can a better understanding of the judging lead to more procedural fairness and outcome acceptance, and ultimately lead to an increased fan engagement? How does that affect fans and non-fans to follow the sport?

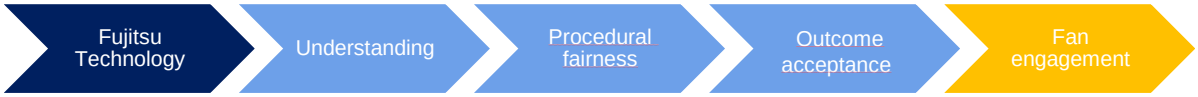



*Figure 4d – Steps to greater fan engagement –* The *fans' path – Fan engagement*

The majority of the fans think that a better understanding of the judging could lead to more people following the sport.

> *"Concerning the fans, I think that it could be a real plus. As a matter of fact, for people not practicing gymnastics, a competition is difficult to follow. First of all, the scoring system is complicated, also the deductions are quite difficult to understand for non-practicing people. The technology would allow a big audience to understand gymnastics competitions. Inevitably, it would make gymnastics more attractive, and more people would watch gymnastics competitions. And maybe also watch more gymnastics on television."* (Fan 1)
>
> *"The eyes of the general public don't see that, they think it's beautiful, but they don't understand why a certain gymnast lost two tenths or something else. So it will make the sport more accessible to the big public. (…) So the more you understand, the more pleasant it's to watch because you understand the subtleties of gymnastics. And it gets more interesting to watch, if you don't understand it, generally people won't get involved because they don't want to put a lot of effort into understanding it."* (Fan 3)
>
> *"Maybe it could be that people who don't understand, will become more a fan because with that additional information they will understand how difficult it's."* (Fan 6)

Other stakeholders also think that new fans could be attracted because they have a better understanding thanks to the additional information.

> *"I think it does make a difference for them, it could help them to better understand. (…) I think it will make it a little more clear how a routine is scored. Because sometimes you hear people say that they preferred a routine, but that it was scored lower than another, this could explain why and how routines are scored. So that's positive."* (Gymnast 2)
>
> *"I don't know if it would attract completely new fans, yes I think, I don't know how, but yes probably. Gymnastics is a difficult sport for people who don't understand it, so that would make it more understandable, so yes I think so. So maybe if they understand how the scores work, they would rather see it."* (Gymnast 5)
>
> *"So if there is something that can be offered where you can follow more what is happening and you get some explanation, (…), then I think that you will enlarge your audience. (…) I think that it can also attract the audience at home. If they effectively use it at the Olympics for gymnastics then it will definitely be brought out by the media, and a very wide public will see it."* (Judge 3)

One judge said it could certainly help to enhance the popularity, but he emphasized that there are more changes needed to do it.

> *"There is much more needed than only the technology to help that."* (Judge 4)

Nevertheless, some interviewees don't think that a better understanding of the scoring will lead to new fans. They think that the additional information will be a great thing for fans, people already following the sport, but they don't think that it will be an added value and attract non-fans watching a competition.

> *"Yes, I think some people will be curious. When you watch gymnastics on television people don't understand a lot. With that application, maybe they will better understand what's happening and how the technique works and such. It will attract curious people, but I don't think it will attract new people."* (Fan 2)
>
> *"I think with that extra information, they will get more interested, but if they will start watching because of that, I don't know. I don't think it will attract completely new people to the sport, it won't go that far."* (Gymnast 3)
>
> *"I don't think it will attract new fans. I just think that the ones that come watch gymnastics, not regularly, but they have something with it, I am sure that they will appreciate it more. (…) So I think people that know how high a gymnast got is interesting, (…), so I think it's a bonus. But I don't think that it will attract, but it will give more comfort to watch."* (Coach 3)
>
> *"The people already watching it will understand it better and will have a better view of it. But I don't think it will incite people to watch gymnastics."* (Judge 1)
>
> *"I don't know, I think that the fans that already exist, will be able to follow the sport better. And maybe for potential fans that would like to be fans but don't understand the scoring. But for people such as me, I don't think the technology will make me a fan."* (Non-fan 1)

Nevertheless, one respondent says that more explanations could make the sport more attractive. This non-fan believes that additional information can attract new fans.

> *"It will make itself more popular, as an audience, when you watch and can better understand how it works."* (Non-fan 6)

This respondent also thinks that the transparency of the judging process will lead to more outcome acceptance and will stimulate people to watch the sport.

> *"Yes, probably that people will watch it more because they will have more faith in the results. I think that the biggest advantage will be that everyone will be judged the same way. (…) So I can imagine that it would stimulate more people to watch because they will understand it. You can justify the scores on the television screen. People will be less skeptical about the scoring."* (Non-fan 6)

The interviewees have mixed thoughts on whether additional information could attract new fans. It will depend from person to person.

## **RQ 3:** How does the use of a hybrid judging system lead to more fan engagement, through better training methods, better performance, and media attention?

The first step in this process to fan engagement is better training methods. The technology could also be used in gyms for training purposes. How will this technology affect training methods?

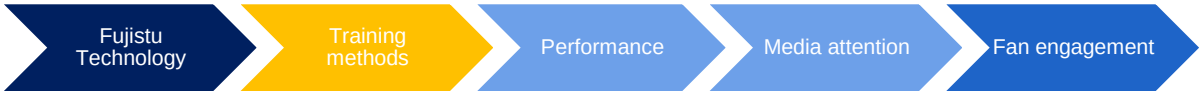



*Figure 5a – Steps to greater fan engagement* – The *gymnasts/coaches' path – Training methods*

Different coaches and gymnasts said that the introduction of the technology would lead to more focus on the execution, and less on the difficulty.

> *"The focus will lie more on the execution of the skills, because often gymnasts perform skills even though it's not executed very well, at least they get credit for the difficulty. With the system, they will work more on execution, because that system can showcase that very well."* (Gymnast 2)
>
> *"Because everyone will want to have the maximum of points to win and thus it's better to do less difficulty very well than more difficulty with errors."* (Coach 1)

The majority of the coaches and the gymnasts think that the technology will be helpful for the training. Especially the visualization of skills and errors will help the workouts.

> *"You know even better on what judges focus because you have a judge in the gym with that detail. We will focus more on details, and I think we will train more smartly and efficiently."* (Gymnast 5)
>
> *"It could be useful to watch and analyze skills that are difficult to succeed. Sometimes the corrections of a trainer can be difficult to interpret by gymnasts. With this technology, the coach can show precisely what he means."* (Gymnast 6)
>
> *"The trainings will be even more detailed, it will also be easier for the gymnasts. They will focus on one skill and they can see where the error is, they will see it, they will see where exactly they get deductions, and then it will be more clear for them."* (Coach 6)

One coach made a distinction between young elite athletes and established high-level elite athletes. Young athletes learn a lot of new skills, while older established athletes work more on the execution of the skills.

> *"I would say for high-level elites like Nina or the seniors, yes because they have some time to do analyses. For me for the juniors where we do development and creation of performance, we are on a higher rhythm of performance. I think that just taking your phone to make a video is already nice, we have a lot of information through this. We already have the televisions on which*

*we can re-watch performances which is already very good. But for seniors like Nina where you reach for every little point the technology could be great."* (Coach 3)

So the technology would be useful to polish movements, but not to learn new skills.

*"To perfect movements, it can certainly help, but to learn new skills that is something else. I don't think it's a big added value in the learning procedures."* (Judge 4)

This leads us to the next step in the process, better performance. How can better training methods lead to better performances at competitions?


*Figure 5b – Steps to greater fan engagement* – The *gymnasts/coaches' path - Performance*

The cost to use this technology in the gym will assumedly be very high. The countries or gyms that can afford such an investment could be advantaged compared to countries that cannot afford it.

*"The negative thing is that it costs a lot. The countries that have a lot of money will have a big advantage to train with it."* (Coach 4)

*"Another negative point is that the countries/clubs with the most money will get even better, because they have the resources, while the ones that cannot afford it will be disadvantaged."* (Fan 2)

So gymnasts who can train with the technology could be advantaged because they could have better performances and could potentially achieve better results at international competitions.

The next step is media attention, how can better performances lead to more media attention?

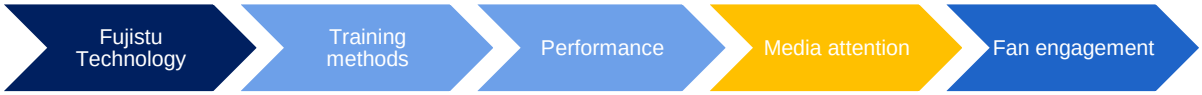



*Figure 5c – Steps to greater fan engagement* – The *gymnasts/coaches' path – Media attention*

Multiple stakeholders mentioned the influence that achievements have on the media attention of the sport. In Belgium, the sport of gymnastics got more media attention because of the international success of Nina Derwael.

*"Well, the sport has become more popular in Belgium because of the performances of Nina Derwael, it comes more in the media. Gymnastics is a beautiful sport to watch but it's not that popular, thanks to the great performances it has become more visible and promoted the sport."* (Gymnast 1)

*"Not many people watch the sport, you can change that primarily by achievements. When we look at Nina, and the women's team that made it to the Olympics, they immediately got more media coverage."* (Gymnast 3)

*"And also the fact that we have Nina now, the fact that she has international success, a lot of Belgians now know her even though they don't necessarily know gymnastics. So I think that if the Belgians achieve results it will make the sport more known."* (Fan 2)

*"If we look on a Belgian scale, the fact that we have Nina Derwael… high-level athletes will make that we get more interested in the sport. (…) Gymnastics, we already see it more on television than in the past. So the media and the investment to bring the athletes to a higher level will help."* (Non-fan 4)

So the stakeholders seem quite outspoken about the importance of achievements to attract the attention of the media.

The last step is fan engagement, how can the media attention influence the popularity of the sport?

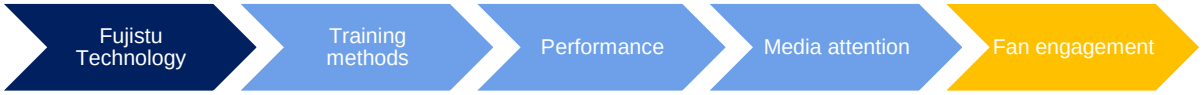



*Figure 5d – Steps to greater fan engagement* – The *gymnasts/coaches' path – Fan engagement*

The respondents gave some examples of different things that could be done to increase the popularity of the sport-related to media. One aspect is the communication and advertising of gymnastics related events.

*"I think for the Belgian, Flemish or Provincial championships, honestly there is not enough advertising about it. If they would commit more to that, I think that more people other than parents would come and have a look at the competitions."* (Coach 6)

*"People don't come to watch, maybe it's not known that there is a competition, so I think that more promotions of competitions could help."* (Judge 4)

*"Maybe there should be more communications about the national team, like "The national team is competing this weekend", and that they then broadcast the competition on television. Like now, I wouldn't even know when they compete."* (Non-fan 1)

*"And maybe more publicity, also for local competitions. (…) So, in general, I would say more communication, more on television and more publicity."* (Non-fan 2)

Another aspect would be to broadcast more competitions, whether it is on television or online. Despite that there are not as many gymnastics competitions, the ones that take place should be broadcasted more. These competitions could be a Belgian championships or international competitions in which the

Belgian team is competing. But even other international competitions where no Belgians are competing, but big stars such as Simone Biles, for example, could attract some viewers.

> *"At a certain moment gymnastics has to be on television on other moments than when there is a World or European championships, and that in that case, you will have more attractivity."* (Coach 3)
>
> *"More broadcasting time for gymnastics. On TV in itself, there is not a lot of gymnastics. Now with our world champion, there is a little more attention, and people more and more get involved in gymnastics. (…) But they could broadcast more competitions, I think that will help either way."* (Coach 6)
>
> *"To show more competitions on television, and promote it more. Because now, when do they show it? Only World and European championships, only when Belgian gymnasts are competing. I would watch competitions on television even though no Belgians are competing."* (Fan 6)
>
> *"To show more competitions, for example, if Simone Biles competes, like really good gymnasts. They have to show more big competitions."* (Fan 7)
>
> *"I have never seen gymnastics on television, so they should show it much more on television. I think they probably show big competitions, but even those I have never seen."* (Non-fan 2)

Some respondents think that the additional information could also be an added value for broadcasts, which could attract more audiences and lead to more broadcasts of gymnastics competition.

> *"I think it's really a great thing for the audience, I think it can really give back some interest to our sport because it's always difficult to understand for people. And with this it will open new perspectives, the people may get more interested in the fact that they better understand the discipline and the judging. (…) and that also for the TV channels, it's a sport that is more measurable so I think it will create more enthusiasm to broadcast it on television with this system."* (Coach 5)
>
> *"The disadvantage of the sport is that there are not a lot of competitions. But if there was an online broadcast with television cameras, where the public can zoom in and watch, and on the side, you get more information, that will be an added value. Web broadcasting with that type of information can be a way to attract more people to the gymnastics world."* (Fan 4)

A different aspect considering the media is how and why gymnastics comes in the media. Most of the time it is because of achievements, but sometimes a negative perception of the sport is created. A coach talked about the negative and wrong perceptions people have about gymnastics. He talks about the way young gymnasts were treated in the eastern countries a few decades ago. The media should stop creating that perception because the sport has evolved since then. He also talked about the #MeToo story that brought the sport in a negative light, again.

> *"(…) to be more attractive we just have to be seen and get away from the clichés. For me making gymnastics more attractive is not the image that we make children work under pressure, like the old videos we see from China. (…) But what has to change is the perceived image from outsiders and also the scandal from the US with doctor Larry Nassar well that is exactly falling again in that negative perception. (…). So for me, making the sport more attractive is gymnasts that stay longer and that are more mature. We want our senior athletes to approach other senior athletes in other sports, increasing the average age of gymnasts."* (Coach 3)

The coach wants the perception of gymnastics to change. Today, gymnastics is not like that anymore, the sport has evolved, and that message should be spread around to eliminate those wrong perceptions. A gymnast talked about commentators taking them down while commentating on their competition.

> *"Nowadays European and world championships are shown on television, whether or not because of Nina, I think it's already getting better. [Do you think the more it's on television, the more people will watch it?] Yes, if they talk positively about us, and that they don't take us down constantly..."* (Gymnast 3)

So the media needs to be more supportive of the athletes, and it also has to take responsibility to not spread wrong clichés about the sport.

The media plays a very important role in the popularity of a sport. Stakeholders are convinced that the more a sport is represented (positively) in the media, through advertising, broadcasts, and coverage in the news, the more people are reached and could potentially get interested in gymnastics.

### **RQ 4:** What are the factors that make competitions boring to watch? How can organizations create a better atmosphere at competitions? How can other rules or other competition formats attract more people?

The interviewees mentioned different factors that make the sport not attractive to watch, they also suggested some solutions to make the sport more popular. Some interviewees mentioned competitions being boring to watch as an argument why not a lot of people watch competitions. However, the opinions from fans differ.

> *"My boyfriend says that gymnastics is boring to watch if you know nothing about it, you don't feel that tension/excitement. You don't notice who is winning or not, when you watch track and field you see who runs fastest and you feel that excitement."* (Judge 1)
>
> *"Yes. I think if I'd go to a competition, not as a judge, (…), then it gets boring because there is no atmosphere in the arena."* (Judge 3)
>
> *"It will be great, I'm a fan of this technology, I think competitions are so boring, but really, it's way too long, way too complex."* (Fan 4)

However, there is a fan that thinks that the atmosphere at competitions is good.

> *"I think that the ambiance at these competitions was good in general."* (Fan 5)

It probably depends on what competitions they go to.

> *"The atmosphere at big competitions is nice, because of the big arena, the music. Small competitions are really boring, first because there is a very little audience, second, because it's organized in boring rooms, third, because there is no good music, and fourth, the people that are in the audience are not enthusiastic. So I think that a better atmosphere will make it more interesting and fun for people to come to watch."* (Fan 7)

Other interviewees mentioned that competitions are too long to watch. Some of them think that the technology will help to shorten these competitions.

> *"I think they have the most advantage because the competitions will be much faster. My parents come to watch competitions, they like it because they see me perform, but it's a lot of waiting, especially if you don't know the other gymnasts. So I think this will make a big difference, it will shorten the competitions. Most of the time is taken by judges, you have to wait until they have a score."* (Gymnast 3)
>
> *"I think it's especially important to sell our sport. For the fans it's great because they immediately have the score after a performance, they don't have to wait. The competitions will last less long, now sometimes a competition lasts two and a half hours, with that technology you could be done in one and a half hours. (…) So I think if you want to sell a sport better, this is very important. A sports competition of more than one and a half hours is too long, and that is the problem of gymnastics."* (Coach 4)
>
> *"Another positive thing is that it would also help to shorten the competitions when it's on television for example. (…) there won't be that much waiting time anymore, so that's clearly a good thing. That is also a thing that is annoying for people who come to watch, or who watch on television."* (Judge 5)

Internationally, some efforts have already been done to shorten the competitions and to make them more attractive.

> *"Sometimes it can indeed be long, but it has already become better, they are more staging the entrance of gymnasts, in the breaks they do some animations for the audience so that has already changed, but this is at big international competitions."* (Coach 5)
>
> *"People don't like to watch warm-ups at competitions, this is why the FIG is shortening them, and not doing them on the podium so that they are less long."* (Judge 2)

The interviewees gave some suggestions on how to make the competitions less boring for the audience. The competitions on the international level have already made some steps to create a better atmosphere at competitions. However, on the Belgian level, a lot of things could be improved. One of the problems why competitions are perceived as boring, especially at Belgian competitions, is because there is a perception that the audience has to be quiet.

> *"Competitions are very quiet, it's like nobody really dares to shout."* (Gymnast 1)
>
> *"And here there is a certain thought that you can't cheer for a gymnast."* (Coach 4)
>
> *"I think that at a lot of normal competitions, the audience doesn't dare to be loud and that they think that they aren't supposed to cheer loudly. So if we can enhance that, that would be great."* (Judge 3)
>
> *"In Flanders, the competitions are really boring, for example on floor, nobody screams to encourage, in Wallonia that is better."* (Fan 7)

A fan also confirms that wrong perception.

> *"Sometimes it's quiet but that's normal, if someone is competing on beam, you have to be quiet, for the concentration of the gymnasts."* (Fan 6)

A lot of the respondents talked about staging the competitions, making it a little bit more of a show. This could be done with more lights, music, and such, but also by changing some rules in the CoP. Also, a different competition format could help, especially team competitions could attract more people.

> *"If you go to a Bundesliga competition, they have another competition format, it doesn't last very long, they work with duels, it's a party, the audience is drinking beer and making noise, there comes a lot of people to watch. Here we still have the perception of a gymnastics competition that lasts three hours on a Sunday and you bring the kids and everyone is 'like sht, be quiet'. I think the most important thing is to shorten the competitions and to create a better atmosphere, that can be with music, that it becomes more a show. Everyone comes to see the Gymgala, it's completely sold out, and then you have the Belgian Championships where there is better gymnastics and there is nobody. So shows and demonstrations, everyone likes to see it, because there are no silent moments, you don't have to wait for scores."* (Coach 4)
>
> *"And there is the discrepancy, the audience wants to see a spectacle, cool things, if someone does two flares on floor than the whole audience is like "Wow", while it's only an A skill. While if someone does a quadruple twist or a triple-double, they will be less impressed, the audience doesn't see the difference between one or two or three twists. But it doesn't have the wow factor of flares, this is why they try to add some on pommel horse to add some spectacle and entertain the audience. I think that they should, it doesn't have to become a spectacle sport, but they should listen more to the audience and do some fun things."* (Judge 4)

> *"I think that for a couple of years they do something great, I think it's since World Championships in Glasgow 2015 they started to make a little bit more a show of it. Like the presentation of the gymnasts and such, before that has never been done, there was never a show around it. And now more and more they make a show around it, I think that that is something that attracts tv-viewers, and even people to come to watch. It's much more interesting, it's much more fun, they name the teams, there is much more visualization with pictures of the team, they make clips in 3D, it's much better. So they certainly have to continue with that, continue to make it more like a show, which hasn't been in gymnastics and was more in other sports."* (Judge 5)

So there are a lot of things that can be done to make competitions more attractive for people to come to watch. The next chapter frames the interviews within the existing literature to examine if the results are consistent with the literature. Then follow the findings for each research question, followed by the implications this research has on gymnastics federations and organizations. Lastly, the limitations of this research are discussed and some suggestions for further research are given.

# 4. Discussion

## 4.1 Discussion

The results of the interviews show some links to the literature. Some of the most important theories that were discussed were extracted and compared to the results of the interviews.

### 4.1.1 Sports marketing

Cortsen and Rasher (2018) revealed that fans become more engaged as data is shared. In the interviews, respondents had mixed thoughts about this. The majority didn't seem to think that the additional information given would attract more fans, but it would be a good thing for already existing fans, it could get them more engaged.

Regarding outcome acceptance in sports, Besley (2010) claimed that those who believe a decision is fair will accept the decision. Cramer et al. (2008) found that transparency is important to evoke a better understanding of the audience and better outcome acceptance. The respondents seemed to agree with these statements based on their answers in the interviews.

### 4.1.2 Bias in judging

Multiple respondents discussed the bias that judges have while evaluating: international, reputation, and sequential bias was found in the interviews. This confirms the literature that bias is present and has a big influence on judging (Kerr, 2016; Radnofsky, 2019; Findlay & Ste-Marie, 2004; Damisch et al., 2006). This literature also suggested that eliminating bias would have positive outcomes for stakeholders (Heiniger & Mercier, 2018; Boen et al., 2008; Damisch et al., 2006; Findlay & Ste-Marie, 2004; Plessner H, 1999). In the interviews, all respondents were glad that the technology could eliminate bias in judging, they were convinced that it would make the judging fairer. The respondents were positive regarding the influence the technology could have on bias in judging. Plessner and Schallies (2005) and V.V (2013)

revealed other factors that influenced the evaluation of judges. Some of these factors were mentioned by interviewees such as shortcomings of the eye, fatigue, and viewing position.

### 4.1.3 Use of technology

The use of technology in sports has a lot of positive effects such as higher accuracy in evaluation (Kerr, 2016). A lot of the respondents were persuaded that the use of the technology would make the scores more accurate. On the other side, as Harding et al (2008) revealed, there is also some opposition toward the use of objective systems to judge. That opposition was also found within the interviews. There was some opposition from the judges because they are afraid of losing their jobs. There was also some opposition from other respondents, they don't want as they describe it, the soul, the magic, or the special touch of gymnastics to fade away. They would like to keep some subjectivity in the sport because it's in its nature. This is why a lot of the respondents still want some human judges in the judging panel to judge the subjective parts such as artistry, presentation, gracefulness etcetera.

Kerr (2016) stated that technologies such as the Hawk-Eye in tennis improve the sport-media connection of competition and the understandability to the audience because commentators can discuss what the technology shows. This was also mentioned by some respondents, the use of technology on broadcasts could give more information, making it more understandable and more attractive to watch.

Multiple respondents compared Fujitsu's technology with the VAR. Some of them mentioned that the VAR was created to decrease discussion, but in fact, there is even more discussion now because of the use of it. So when Fujitsu will implement its system, it will have to make sure that there will be no more discussion possible, otherwise, it will lose its purpose. They also think that because of the use of the technology, maybe there won't be a discussion about the fault of the judges anymore, but about the fault of the judges and the technology, so it would be even worse. But, one respondent pointed out that Fujitsu's technology would be better than the VAR because to use the VAR people have to intervene and it is only used when people want it to be used, while Fujitsu's technology will be used for the entire competition, without people intervening, which leads to less discussion. So if the technology is used for everyone without the intervention of humans, the technology would lead to less discussion, in contrary to the VAR. Lastly, another respondent talked about the loss of the charm of soccer because of the introduction of the VAR, he is afraid that the same will happen with gymnastics with the introduction of the technology. So some respondents are concerned that the special touch or feeling will disappear with the introduction of technology.

Some respondents compared Fujitsu's technology with the IRCOS system. At the beginning of its implementation, the Difficulty judging panel could always watch the recording of a routine again if they wanted to. Because of that, judges knew that they always had a back-up, which made them judge with less vigilance, which leads to more time to come up with a score. Now, the FIG has removed the IRCOS system from the judging table, so that judges would again judge with full vigilance. IRCOS is now only used in case of an inquiry. If the FIG decides to implement Fujitsu's system for the D-panel to work along the D-judges, they cannot make that same mistake, judges should not be allowed the make use of the

system when they want to. A solution would be to eliminate the D-judges and let Fujitsu's technology calculate the D-score alone.

### 4.1.4 Procedural fairness and outcome acceptance

Hollander-Blumoff & Tyler (2008) revealed that increased levels of procedural fairness lead to more outcome acceptance. A lot of the interviewees seemed to agree with this statement as they said that because the system would eliminate bias, fans, gymnasts and coaches would agree more with the given scores. Leveaux R. (2010) found that the use of technology would reduce the incidence of controversial decisions and lead to fairer competition. However, he also said that the technology should only be an aid of a referee to enhance better decision making. A majority of the respondents had the same opinion about using Fujitsu's technology solely as a helping tool for the judges.

Based on the answers of the interviews, the six characteristics to describe whether procedures are fair of Leventhal et al. (1980) are looked at to see if they are met with when the technology is being introduced for the Difficulty score. The first characteristic is consistency. The use of the judging system as a helping tool will allow the judging to be more consistent, it will definitely be consistent for the D-score, but not for the E-score as judges will still evaluate that. The same reasoning applies to the characteristics of unbiased suppression, accuracy, and ethicality. The characteristics will be met for the fairness of the D-score, but not for the E-score as that will still be evaluated by humans. The representativeness characteristic which was already met before the introduction of the technology will still have to be met with the introduction of the technology. The FIG will have to make sure that the development of the judging procedure still integrates the interests of the gymnasts and coaches. Regarding the correctability, the FIG will have to make sure to develop procedures in case there are some questions about the way a gymnast was evaluated by the technology. There already exist some procedures for the D-score, but will such a procedure still exists when it is the technology that evaluates, or maybe such a procedure will not be needed because of the accuracy of the technology. Such procedures do not exist for the E-score. To conclude, the introduction of the hybrid technology to evaluate the D-score will not make the entire judging process fairer. It will definitely make the D-score process fairer, but for the E-score nothing changes.

### 4.1.5 AI and fairness

Multiple studies have revealed that AI systems are not bias-free by definition (Shrestha et al., 2019; Rhue, 2019). Shrestha et al. (2019), revealed that there is increasing evidence that AI-based decision-making may introduce or amplify different biases. This is because AI is trained on data that could be biased (Rhue, 2019). The respondents didn't seem to think that the technology could be biased, almost all of them think that the use of the technology would eliminate bias such as international and reputation bias in judging. The reason that machines can't think, while humans do. But literature proofs that this is a wrong perception, although a lot more research needs to be done on this topic.

However, some of the respondents were wondering if the technology would be biased based on body type, which is a justified concern. For the judging system to be completely fair, Fujitsu and the FIG will have to make sure that the AI has no bias at all if it wants to implement it for judging at competitions. A

Fujitsu official has stated that determining the position of athletes' joints is more precise, given the variation in athletes' muscle thickness, if the computer has individual data (Keh, 2019). So based on this statement, it looks like Fujitsu wants to diminish the body type bias as much as possible.

## 4.2 Findings for each Research Question

**RQ 1: How do judges welcome the arrival of a helping tool?**

It seems that most judges will need time to see and embrace which advantages the hybrid system has for them. As a helping tool, most judges seem to like the introduction of an assisting tool, as they acknowledge that they make errors sometimes and wish they could be more accurate. These errors are made because of human-related factors such as the shortcomings of the eye or context-related factors such as viewing position. The judges don't seem to have problems with the technology being used for the D-score, as that is straightforward. But regarding the E-score, they are reluctant. They are afraid that if the introduction is successful for the D-score, it won't take much time before the technology will also be used for the E-score, which would mean that they lose their jobs. Most of the judges are also against the technology evaluating the E-score because that includes the artistic evaluation, which a technology will never be able to judge as humans do. Especially the WAG judges don't want AI to judge artistry. So as a helping tool, judges are quite positive about the arrival of the technology, as long as they don't lose their jobs and that humans can still evaluate subjective aspects such as artistry.

**RQ 2: how does the use of a hybrid judging system lead to more fan engagement, through better understanding of decision, procedural fairness, and outcome acceptance? (See figure 4)**

The respondents seem to think that the use of a hybrid system could lead to a better understanding of the scoring process. The technology can offer some additional information about the judging to the audience. Judging in gymnastics can be quite difficult to understand, especially for people new to the sport. Not understanding the scoring systems could be one of the most important reasons why people don't follow the sport, despite it being a spectacular and aesthetically pleasing sport to watch. The understandability of the scoring is especially important for people who pay attention to scores, people who don't pay attention to that don't really mind that additional information is given. As a lot of the respondents pointed out, they don't think that it will attract new people to watch the sport. Therefore more things are needed than just providing some information and explanations. However, it could be a big added value for fans who might get more engaged because of that extra information, this confirms Cortsen and Rasher (2018) theory.

However, the respondents think it could be a big added value if that additional information is featured on broadcasts as well as in the competition arena for the audience. That information could make people understand the judging and the difficulty of the sport more. Just like Hawk-Eye which also improved the sport-media connection of a competition and the understandability to the audience (Kerr, 2016).

Multiple respondents said that a better understanding of the judging process would possibly lead to a more fair perception of the judging process and more acceptance of the scores, because of the additional explanation making the process more transparent for the stakeholders. This reasoning can

be confirmed by the literature (Hollander-Blumoff & Tyler, 2008; Leveaux R., 2010). The judging procedure will be fairer for the gymnasts because it could lead to more objective scoring. This could then lead to less discussion about scores, as the system will be able to provide some explanations and because it won't be biased or won't cheat. The respondent reasons that machines can't think, while humans do. The technology won't evaluate differently depending on the reputation or the nationality of a gymnast. And it can also not think about who was already judged and who still needs to come. However, literature doesn't support these statements as AI could be influenced by bias because it could be trained on biased data (Shrestha et al., 2019; Rhue, 2019).
The stakeholders are also convinced that the technology will reduce cheating in judging. However, bias and cheating occur primarily in the E-score, while the technology would only be used for the D-score in a first time. So the technology can only lead to increased procedural fairness and outcome acceptance for the D-score. This can also be confirmed by the six characteristics of Leventhal et al. (1980). For this reason, some judges proposed to use the system for the D-score, and then add more judges to the E-panel to further reduce the possibility of cheating there.

On the other hand, gymnasts and coaches fear that the judging with the technology will be very harsh, therefore some propose that the FIG adapts its CoP to the technology. The metrics that the system will provide such as the height and rotation angles could be used as criteria for judging. Some of the respondents think that there should be a margin on the metrics, so that a small difference in degrees from perfection can still be considered as perfect. On the other hand that preciseness will push the athletes to be as close to perfect as possible, which could be a motivation for some.
Yet, some interviewees think that the introduction of the technology can still lead to increased fan engagement. The use of a full AI system instead of a hybrid system could have more effect on fan engagement as it would lead to procedural fairness and outcome acceptance for the entire score. But again it will only have an influence on people that pay attention to scores and rankings, which is, based on what was said in the interviews, a minority of the spectators.

However, some argue that subjectivity is in the nature of the sport and that there will always have to be some room for subjectivity. The use of a full AI system will diminish that. This is also why a lot of the respondents still want some human judges in the judging panel to judge the subjective parts such as artistry, presentation, gracefulness etcetera. There are different reasons why not only the judges but also other stakeholders don't want the technology to take over completely. First of all, there are some questions about the capabilities of the technology to evaluate the artistic part of Artistic Gymnastics. Then some questions were raised about if the technology would evaluate the same way judges do for the execution, will different techniques for the same skill be evaluated differently? Can the technology differentiate performances done with high tonicity, and others done with fewer tonic bodies? There was also a concern about the evaluation of body types, human judges are supposed not to evaluate gymnasts differently based on their body types, will the technology also do that? To not let the body type influence the technology's evaluation, Fujitsu gathers a lot of data from as many different gymnasts as possible to calibrate its system (Keh, 2019).

So the subjectivity of the sport brings some contrarieties with it. The respondents think it should be reduced to attain fairer judging, but on the other hand, it should be kept because it is the nature of the sport. Fans and non-fans are aware of that subjectivity and think it is good if the technology can reduce that, but it is not an argument for them to not follow the sport. So for now, the sport should decrease its subjectivity, but it doesn't have to disappear completely. That opposition toward the use of technology can be confirmed by Harding et al (2008).

So procedural fairness and outcome acceptance won't have such a big influence on fan engagement, as understandability does. A full AI system would have a bigger effect than a hybrid system. But there is a lot of resistance of the stakeholders to let the technology take the place of the judges completely for multiple reasons such as subjectivity, the evaluation of artistry, human touch, and the equality of body types. Table 5 shows a general conclusion of the stakeholder's thoughts on the use of Fujitsu's technology as a hybrid judging tool and the different steps towards fan engagement.

*Table 5 – Conclusion Figure 4 – The fan's path*

| | **Technology perception** | **Understanding** | **Fairness** | **Outcome acceptance** | **Fan engagement** |
|---|---|---|---|---|---|
| **Judge** | Reluctant. As a helping tool, they accept it, are against if it replaces them. | Divided. Some think it could help some (non-)fans, others don't. | Positive. They know they make errors, it will help eliminate that. | Positive. The stakeholders will have more faith in the scores. | Reluctant. Are not convinced it will attract new fans. It will help existing fans. |
| **Coach/ Gymnast** | Positive. It could help the sport to move forward. | Positive. The audience will understand what they are doing. | Positive. They believe they will be judged more fairly. | Positive. They will have more faith in the scores they get. | Reluctant. Are not convinced it will attract new fans. It will help existing fans. |
| **Fan** | Positive. It could help the sport to move forward. | Positive. They like the additional information they will get. | Positive. They believe the gymnasts will be judged more fairly. | Positive. They will have more faith in the scores given. | Positive. They believe that it could attract more fans to the sport. |
| **Non-fan** | Divided. Some think it could help the sport, other don't. | Reluctant. It may help to understand a bit better but are not convinced. | Positive. They believe the gymnasts will be judged more fairly. | Positive. They will have more faith in the scores given. | Reluctant. Are not convinced it will attract new fans. It will help existing fans. |

In general, the stakeholders are positive about the new technology that is coming. Especially if it is used as an additional tool, then almost all interviewees were positive-minded about the introduction. However, most stakeholders are not ready yet for the technology to take the judging over completely. For now,

Fujitsu emphasized that they would introduce the system as a helping tool for judges, which might turn out great.

**RQ 3: How does the use of a hybrid judging system lead to more fan engagement, through better training methods, better performance, and media attention? (See figure 5)**

The stakeholders are quite positive about the use of Fujitsu's technology as a training tool. Coaches and gymnasts say that the introduction of the technology could be helpful for trainings, especially to perfect skills. The technology is perceived as less helpful in the learning phase of a skill. Especially the visualization of skills and errors would be a big added value in the gym. However, the use of Fujitsu's technology in gyms will only give an advantage to countries where they can afford the system. So it will probably have effects in countries that have a lot of money which often already have big gymnastics programs and where the sport is often already quite popular. These gymnasts who can train with it will be able to train with a system that will also be used as a judging tool at world cups and world championships. This gives an enormous advantage to these gymnasts and those countries who can potentially have better performances and better results as a result of training with a judging system that will also be used at competitions. So there could be a threat of the biggest programs getting even better and more popular, while the small programs don't get that chance to keep up with the big programs.

The technology could help gymnasts to achieve a higher international level and eventually have better performances. As a consequence, better performances can result in more media attention, this could lead to more income for the gymnasts, through sponsorships for example. More income could mean that gymnasts can take it slower on their studies, and put more effort into their sport, which could also lead to more achievements. Media are interested in medals and achievements that seek the attention of people who might get interested in the sport because of that. The respondents said that more media coverage because of achievements certainly helps to attract fans. In Belgium, we have seen that with Nina Derwael, since she won multiple European and World titles, the Belgian media got more interested in the sport, and the sport got more media coverage.
However, multiple respondents pointed out that more attention in the media is not enough to attract new fans. More communication and advertising about the national team and domestic and international competitions could trigger people to follow the sport. Another factor is to give enough opportunities to a large audience to follow the sport easily, therefore broadcasting more competitions on television and the internet could help. Ultimately, that increased positive media attention could lead to more fan engagement, as the sport is more in the news and more available for people to follow it.

Table 6 shows a general conclusion of the stakeholder's thoughts on the use of Fujitsu's technology as a training tool and the different steps towards fan engagement. Non-fans were left out as they weren't asked something about the technology as a training tool.

*Table 6 – Conclusion Figure 5 – The gymnasts/coaches' path*

| | **Technology perception** | **Training methods** | **Performance** | **Media** | **Fan engagement** |
|---|---|---|---|---|---|
| **Judge** | Mostly positive, it will help for training purposes. | Positive. It will be very helpful to perfect skills. | Positive. Gymnasts can have better performances. | Positive. Better performances lead to more media attention. | Positive. More media attention can possibly attract new fans. |
| **Coach/ Gymnast** | Mostly positive, it will help for training purposes. | Positive. It will be very helpful to perfect skills. | Positive. They can have better performances. | Positive. Better performances lead to more media attention. | Positive. More media attention can possibly attract new fans. |
| **Fan** | Mostly positive, it will help for training purposes. | Positive. It will gymnasts them for training. | Positive. Gymnasts can have better performances. | Positive. Better performances lead to more media attention. | Positive. More media attention can possibly attract new fans. |

The stakeholders seem to be on the same page regarding the implementation of this technology. All of them think that it can have positive effects on training methods and media attention. The technology is a step in the right direction but won't be enough, it will take more efforts to make the sport more popular.

**RQ 4: What are factors that make competitions boring to watch? How can organizations create a better atmosphere at competitions? How can other rules or other competition formats attract more people?**

During the interviews, a lot of the respondents mentioned some factors of why gymnastics is not very popular, particularly in Belgium. Based on the interviews, the following factors were considered playing a role in why people don't follow the sport: they don't understand the judging, they don't feel tension or excitement, the competitions are too long to watch, the competitions are boring to watch and people are not aware of competitions and where they can see them. All these constraints can be solved. The technology could play a role in attracting fans by providing information, which could lead to people understanding it more, and feeling more excitement as they have a better image of how difficult the sport is. The technology could also play a role by shortening the competitions as the judging will take less time with the aid of the judging system.

Other factors can be solved without the technology. Respondents mentioned that a lot of competitions are quite boring to watch. A big reason why that is is that the audience has the perception that they have to be quiet for the concentration of the athletes. To change that perspective, the speaker could encourage the audience to be loud and cheer. The organization could also play some loud, engaging music and play with lights for example to get the audience going. Another way to make it more fun is to stage competitions more, this is already happening at bigger international competitions. Some respondents are convinced that that could help to attract people to watch the sport. A game of lights, music, and a good speaker could have a positive influence on the perception of competitions.

People also feel more engaged when they can cheer for a team instead of an individual, so other competition formats such as team competitions could also attract more audience. Other scoring rules was also a suggestion made by some respondents, this could also make it more exciting for an audience. For an uninitiated audience, the current scoring system makes it difficult to know who is winning. For example, a scoring system such as a duel format would be more understandable for the audience. The CoP could also take into account what thrills the audience such as high flying skills and flares and adapt to it. So that could bring more excitement to the competitions as well.

**So, what do stakeholders think of the implementation of a Human + AI judging system in gymnastics?**

Stakeholders have different opinions on the question of whether Fujitsu's technology could enhance the popularity of the sport. A lot of them think that the technology will be attractive for already existing fans because they will be interested in the additional information. There is some discussion about whether the technology would attract completely new people. What is sure, is that the use of the technology alone will have little effect on fan engagement, there are other initiatives and investments needed to take the sport to another level.

## 4.3 Implications

The results of this research show some practical relevance for organizations within gymnastics, whether it is on a local, national, or international level.

On a local and national level, the sport of gymnastics doesn't seem to attract a lot of spectators to its competitions. These competitions could be made more attractive in different ways. A first suggestion is to communicate to the audience that they are allowed to be loud and cheerful. That communication should be done in the arena where the speaker encourages people to cheer. This communication could be reinforced by giving or selling attributes to make noise when the spectators enter the arena. Another way to make competitions more entertaining is by playing some popular music in between rotations and do some kind of entertainment for the audience, while the gymnasts are rotating (going from one apparatus to the other) or warming-up. Other competition formats could also work, team competitions, or a duel format, or a combination of the two has shown to be very attractive for spectators in countries abroad. Organizations also have to advertise these events more with online (e.g. social media, website) as well as offline (e.g. billboards, posters, commercials, etc.) advertising.
A way to get more media attention is through the achievements of gymnasts. To attain such achievements, federations could invest (even) more in their athletes. These could be investments in infrastructure, coaching staff, wages, or additional support for gymnasts to combine their studies and sport, for example.
Lastly, more broadcasts of competitions can also lead to an increase in the popularity of the sport. These broadcasts can be on television as well as online. A Belgian championship as it is now doesn't have to be broadcasted because nobody would watch it. After all, it is quite a long and silent competition. If some measures are taken to make that competition more attractive, and there is more advertising and

communication about it, then it could eventually be broadcasted online, because there will be demand for it. Also, international competitions such as world cups should be broadcasted in Belgium. If there are more opportunities to watch gymnastics, eventually more people will watch it and will see the Belgian gymnasts performing on the international stage which can increase fan engagement.

The same applies to gymnastics on the international level. The FIG has already worked on making competitions more attractive through entertainment and such, this is a positive evolution and should be applied to even more events. But the FIG could invest more in making international competitions more available to the big audience through international broadcasts for example.

This research also provides some recommendations for Fujitsu. Fujitsu needs to address stakeholders' concerns about the evaluation of different body types of gymnasts, as well as the other biases that influence judges' evaluation.
This study suggests the importance of Fujitsu and FIG's communication strategy of the technology. Towards judges but also towards the other stakeholders, it is important to emphasize that the technology will only be used for the D-score at the moment and that it is not the goal to replace human judges. This way the stakeholders won't have a negative attitude toward the introduction and further development of the technology.

Fujitsu should market its technology as not only a judging tool but also as a marketing tool that provides information for broadcasts for example. It should work on its communication towards broadcasters, the technology is a great tool to enhance broadcasts and can attract a lot of people. This is important so that broadcasters will have the desire to buy the right to use the information Fujitsu gets. If broadcasters and organizers of gymnastics competitions buy Fujitsu's technology to top up their activities, it can catch the attention of the media because of the use of a revolutionary technology. So to increase the popularity of the sport, Fujitsu and the FIG should emphasize the use of the technology as a marketing tool, next to the judging and training tool.
The technology as a judging tool will probably have less influence on the popularity of the sport, as a lot of the interviewees don't think a lot of spectators pay attention to procedural fairness and outcome acceptance. The same applies to the technology as a training tool, it will be very helpful for the gymnasts and coaches, but it doesn't directly influence fan engagement. Nevertheless, it is also important that Fujitsu markets its technology as a training tool too, to generate more income.

To conclude, there are a lot of possibilities to enhance the popularity of gymnastics, whether it is through the use of technology or not. A lot of people know that it is a beautiful sport to watch, that is the reason why gymnastics is one of the most-watched and attended sports at the Olympic Games. Now, the trick is to make that audience follow the sport in-between Olympic years.

## 4.4 Limitations

This study has certain limitations. Because the technology is still in a developmental phase, there is not that much information available. This made it also difficult for the interviewees to imagine how that technology would look like and what implications it could have, even though a video from Fujitsu was shown to give them something visual.

This is a qualitative study, the interviews are not statistically representative, but only indicate what stakeholders think about the technology. No clear conclusions can be made whether the technology will lead to more fan engagement or not. This study only points out the perception of the respondents and what the stakeholders think that the problems are of why the sport is not popular in between Olympic Games.

## 4.5 Suggestions for future research

Two interviewees are physiotherapists, they mentioned how the technology could be really helpful to know how gymnasts get injured for example. Future research in the medical field could be done about the technology as a tool for physiotherapists for gymnasts.

Once the technology is implemented as a judging tool at international competitions, a quantitative research could be executed to compare the situation before and after the implementation of the technology. Do fans understand the scoring more? Do stakeholders think the judging is more fair now? Do the stakeholders have more faith in the scores? Are more people attracted to watch the sport? What do broadcasters think of the additional information that is given, does it attract new people to watch broadcasted competitions? Such a quantitative study could be executed by showing a video of a broadcast with the use of the technology versus showing a broadcast without the use of the technology, for example. Such a quantitative study could be statistically relevant for the implications of the implementation of the technology.

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# Appendices

## Appendix 1 – overview of interviewees

| | **Birthday date** | **Nationality** |
|---|---|---|
| **Gymnasts** | | |
| 1. Laura Waem | 5/08/1997 | Belgian |
| 2. Rune Hermans | 9/05/1999 | Belgian |
| 3. Florian Landuyt | 10/05/1996 | Belgian |
| 4. Noah Kuavita | 28/07/1999 | Belgian |
| 5. Jonathan Vrolix | 9/11/1996 | Belgian |
| 6. Dorien Motten | 19/07/1991 | Belgian |
| **Coaches** | | |
| 1. Matthieu Zimmermann | 22/02/1986 | French |
| 2. Ward Van den Bosch | 28/08/1968 | Belgian |
| 3. David Spagnol | 18/12/1982 | Belgian |
| 4. Koen van Damme | 29/04/1987 | Belgian |
| 5. Marjorie Heuls | 23/09/1976 | French |
| 6. Julie Croket | 1/07/1994 | Belgian |
| **Judges** | | |
| 1. Tatjana Decaesteker | 19/04/1993 | Belgian |
| 2. Iliana Fegya | 16/10/1963 | Belgian/Ukrainian |
| 3. Marleen van Dooren | 24/ 06/1966 | Belgian |
| 4. Sander Raeymaekers | 27/02/1988 | Belgian |
| 5. Eleni Lari Carillo | 8/07/1993 | Belgian |
| **Fans** | | |
| 1. Hannah Mouillot | 12/03/1998 | French |
| 2. Marine Dutoit | 10/07/1997 | Belgian |
| 3. Frédéric Debourse | 13/09/1966 | Belgian |

| | | |
|---|---|---|
| 4. Thierry Deleuze | 7/01/1976 | Belgian |
| 5. Jean-Luc Deloof | 20/11/1968 | Belgian |
| 6. Ilse Hoebeke | 25/10/1966 | Belgian |
| 7. Emmanuelle Decoster | 15/07/1998 | Belgian |
| **Non-fans** | | |
| 1. Margaux Vanhaute | 13/04/1997 | Belgian |
| 2. Zora De Buyck | 30/03/1998 | Belgian |
| 3. Bart Dutoit | 9/09/1968 | Belgian |
| 4. Fred Catteau | 9/03/1976 | Belgian |
| 5. Sébstien Catteau | 26/03/1978 | Belgian |
| 6. Ivan Claeys | 16/09/1961 | Belgian |

# Appendix 2 – Interviews

## 2.1 Gymnasts

### *1. Laura Waem*

**What is your first reaction after seeing this video and being introduced to the technology?**

I had already heard about this technology at the time when I was still doing gymnastics that they were planning to develop that. In itself, I think it will make it easier for the judges and it will make the judging fairer because in gymnastics there is still some nepotism playing. For example, one country will help the other when it comes down to it. In gymnastics, the difference between two gymnasts can sometimes be only one tenth of a point, and I think that in that area the technology will make it better, to let the judging procedure happen more fairly I think.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Positive is that everything will be more based on reality and there will be less favoritism between the judges themselves because, in my eyes, the images don't lie if everything is well… I don't know how it is put together, how the technology is made. But I think that you can trust that more.
Negative, I think that the technology will look at every little detail, know it is possible that the eyes of the judges can't see everything, such as a poorer executed movement, but if it happens like that for every gymnast, then it is like that for everyone because the image says is. Which in fact will be good because there won't be a discussion about it anymore.

Is it the intention that the judges will still be there on the competition floor? [Céline: yes for now both judges and the technology will be used, but in the future, it is possible that they will completely replace them. But there is still a problem with the artistry component.] Oh yes that is true, that is maybe another negative thing, how can such a technology measure if it is graceful or not? I think that can still be evaluated by a judge to evaluate the appearance. Because yes the technology can probably measure the amplitude of the legs perfectly, but the gracefulness and such, if you are on the rhythm of the floor music, I cannot really imagine that technology can do that.

**Which impact do you think this technology will have on attracting fans to watch/follow the sport?**

In the video, they showed the application, that you can follow the competition on it, but I don't know, if I go to a competition as a fan, if it would be an added value. I come to watch the gymnasts doing gymnastics live, and not to see on an app how the angles are. Maybe to get to know something more about the scoring, because I saw that they showed how much points they award for each skill, I think that that could be useful because some people know nothing about how that works, so that would be an added value. But on the other hand, I don't know if I personally would use it, because I prefer to watch the performances live.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

I think that the judges will feel some pressure because they will feel they will lose their job, most judges don't do that as a job, but as a hobby. But I can imagine that with the technology they will think that they won't be able to judge competitions anymore.
On the other hand, for gymnasts and trainers, it will be positive because you can use it at trainings to see how the skills look like and how they will be evaluated by the technology.

To the fans, I don't think they will bother that there is a new technology in the sport, but on the other hand, they can use the app the understand to scoring better and I think that is the advantage for them.
I think gymnasts will take the most advantage of it for the trainings. Yes, it is true that the scoring will become more objective which I think is really good, but it has always been a part of the sport that it is never objective. Sometimes it is like countries have agreed to help each other even if it is about little things such as a bent knee or a handstand that they still give, but it can be the difference between a medal or not. So this is what I really like about the technology, and I think that some judges will think "oops, we won't have it under control anymore".

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward? Are there things that are not important and could be left behind? Why?**

Yes, I think there are other things that could help. Competitions are very quiet, it is like nobody really dares to shout. But if you compare this to college gymnastics in the United States, there is a good atmosphere, I would like to once go there it seems so much fun to me to compete there. I don't know why it is like that there, maybe it has evolved like that over the years. Yes there they use the 10.0 scoring system, but I don't know if that is what it makes that there is so much fun during competitions there.
Well, the sport has become more popular in Belgium because of the performances of Nina Derwael, it comes more in the media. Gymnastics is a beautiful sport to watch but it is not that popular, thanks to the great performances it has become more visible and promoted the sport. It also depends on how much sponsors the sport has, in Russia for example the sport is much bigger. For the girls, the sponsorships are increasing because of the performances. But I think if you don't invest in it, or you don't try to attract sponsors… it is like it is a reward. But maybe you could first invest in it to enhance the program, like for the men's team for example. Now they are like, they don't have great performances, so we don't invest in it, but if you don't invest, the results won't get better.

I want to repeat that I really think that it will enhance the sport by making it more objective and that there will be less discussion like "is the angle good or not, is the turn fully completed or not", these are things that you can see perfectly with the technology which I think is great.
I think the technology won't mind the fans that much, as a fan I think I would say that the technology is good because it adds value, it's only an improvement, so of course, it is good.

But when you talked about the artistic component, then I don't stand fully behind it anymore because I think that that should be evaluated by humans.

Then about the app, I don't see the added value to watch on your smartphone, while you could watch it live just in front of you. If they add some explanations such as the difficulty for example, then I think it is good. But on the other hand, I think people will be looking more at their smartphone than to watch the gymnasts performing live. I think it will be more of a distraction and that the atmosphere in the arena will be even more quiet.

*2. Rune Hermans*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think it is a good system, but what I have with all the technologies is, what if it fails or breaks down at a competition, what then? But it is an advantage that with that for example they can't favor the Americans, over Hungary, because it is a computer and it can't think about it. I think that sometimes it still happens at competitions. Or for example, at the beginning of the day, the judges are fresh, but at the end of the day, when judges have been there for 10 hours, it is normal that they miss some things, they are less sharp. It happens either way, not to such a big extent, they keep it into account, but it certainly has an effect. The system doesn't have such problems, but if it fails there is a big problem, then you still need judges. And also for the artistic part, I don't think that a robot can see that. For the skills, if it works well, then it is absolutely a good technology.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The disadvantage is that it is technology, it can always crash, or there is no Wi-Fi or whatever. The advantage is that there is no bias, everyone is treated the same way, it is super accurate.

**What impact could this technology have on training methods?**

I think that the trainings will be more specific. The focus will lie more on the execution of the skills, because often gymnasts perform skills even though it is not executed very well, at least you get credit for the difficulty. With the system, they will work more on execution, because that system can showcase that very well. Gymnasts can cheat less with that technology, so I think they will do less difficult skills, but perform it as perfectly possible. You will see cleaner gymnastics.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

I don't know if it is an improvement for the fans. I don't think it makes a difference for them, because they see the score appear anyway, it doesn't change anything for them. [Céline: they also show for example how long they hold the position and the angles and such.] Oh yes, then I think it does make a

difference for them, it could help them to better understand. But if there is someone who really doesn't know anything about gymnastics, they will still not understand the difficulty score. I think it will make it a little more clear how a routine is scored. Because sometimes you hear people say that they preferred a routine, but that it was scored lower than another, this could explain why and how routines are scored. So that is positive.

But for judges, it is negative, because they won't have work anymore. If the technology is used as a tool to help them when there is a discussion for example, then that is absolutely an advantage. Because then there will be no more discussion between the judges of who saw what.

So I think that fans would have the biggest advantage. For the gymnasts, everything gets penalized more harshly, this is a disadvantage. The advantage is that everyone is treated the same way, which is very important. But the judging will be harsher, especially at the beginning the transition will be hard, the scores will be much lower. Once everyone understands it, it will get better. But for the trainers, I don't think it will have much influence.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think they are already making efforts to let it reach the news, that people get reminded that gymnastics exists. They could let it appear even more in the news so that people will watch it more and understand it better. It is like a vicious circle, you need fans to get the sport more popular, but the sport needs to be popular to attract new fans. If you showcase it more to the world, people will be like "oh gymnastics is cool". At the Olympic Games, it is already the case, a lot of people are watching gymnastics at the Games. But only then, because during the year soccer is broadcasted every weekend, gymnastics almost never. There aren't that many competitions and you also can't do that many competitions. I think this plays a role in why soccer is that popular and gymnastics not, you don't have a competition every weekend. It is impossible for gymnasts to compete each week.

**Are there things that are not important and could be left behind? Why?**

No, I think that everything has its function. Seeing the angles and seconds can be helpful for judges if it is used as an extra tool as a reference value. I don't think that it's an added value for fans to know the angles, if it is explained then maybe yes, especially for fans that already know something about it, then I think it is very interesting because you don't always see the angles from where you are positioned in the arena. For people that know nothing about it, that information is redundant. Then everything should be explained and it will more look like a documentary than a competition than there is no fun anymore. For the gymnasts themselves, it is good for them to know how they are evaluated by the technology, but in the beginning, it will be confronting because they will see that it isn't good.
Die-hard fans will like that technology, and new fans may understand it a bit better why someone scores better than someone else.

Gymnastics is subjective, you work with people, regarding the artistic aspect, everyone's taste is different some people like things that others don't. Of course, there are rules that need to be followed which makes it more objective, but there will always be a subjective part. Is that wrong? If it is to your advantage not, and if it is to your disadvantage then yes. The technology will make it more objective, but then you miss the artistic part.

*3. Florian Landuyt*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think you saw my reaction, I think it is magnificent that it is possible, or maybe not possible because I am somewhat in that branch, I study Applied Informatics, so I know something about it, but still to see it applied in gymnastics, it is very cool that they are occupied with it. I saw them working on it in Stuttgart, there were all Japanese at tables constantly busy on their computers, it is very nice.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The advantage for the people at home is that they see extra information on television and how judges get to a score, the D and E scores. But the disadvantage is for the gymnasts themselves, for example at high bar you do something almost to handstand, a judge will say "okay it is a handstand", they won't be too strict. While a machine will see it is 97°, they will take one tenth. For gymnasts it will be disadvantageous, but also for judges, their jobs will disappear, but that is the industry. These are disadvantages, but I think there are more advantages attached to it. I think that it can attract more viewers, a lot of people now say what it consists of, how the scoring works, and now it can all be explained perfectly.

**What impact could this technology have on training methods?**

I haven't really thought about it. We already have some TVs on which we can re-watch performances to directly see what we did and what was wrong. I think that technology can be really positive for gymnastics and for the trainings.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes and no for gymnasts, they will get penalized more, but it is also good because it will motivate us to keep pushing to get better and to make fewer errors. A big advantage is that everyone will be judged the same way. I think you know that the Chinese and Japanese even though they make some errors, that doesn't really matter for them. While for Belgium who hasn't a name, we will get judged more harshly, every time three tenths off. And now with that technology, there won't be such a distinction. They aren't especially less strict because of their reputation [of the Chinese and Japanese], but also yes

they are. The judges expect them to be good so they are more bound to overlook such things, well not for big errors obviously. I think it can't be bad for smaller countries.

For fans also. I think they have the most advantage because the competitions will be much faster. My parents come to watch competitions, they like it because they see me perform, but it is a lot of waiting, especially if you don't know the other gymnasts. So I think this will make a big difference, it will shorten the competitions. Most of the time is taken by judges, you have to wait until they have a score.

Also for judges yes and no, their jobs will disappear, which is not good. And… I don't really see any advantage for the judges.

**Do you think fans find it important to know how the scoring works?**

Yes, I think so. A lot of people watch soccer and tennis, they know the rules, it is not difficult. But to watch a gymnastics competition, when you don't know what you see, it can be boring. Well it is nice to watch and it may be spectacular, but they don't know why you get a 14.5 or 14.7. I think with that extra information, they will get more interested, but if they will start watching because of that, I don't know. I don't think it will attract completely new people to the sport, it won't go that far. [Céline: What could help?] The scoring system, formerly it was on 10 points, I think that is the only thing that could help. But is not fun for the gymnasts now to go back to that system. I don't exactly know how it was back then, but the difficulty was much lower, the focus was more on execution, which is beautiful but I wouldn't like to go back to that system.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think they are already doing a good job, for example at big competitions they are already explaining what happens to the audience, and they do some kind of show in between the rotation. For example in Stuttgart with the music and the lights, they really try it, and I think it works. But I don't know if they will attract new people with it.

Regarding media, we are not the only sport that gets not that much media attention. Not many people watch the sport, you can change that primarily by achievements. When we look at Nina, and the women's team that made it to the Olympics, they immediately got more media coverage. So we [the men's team] can get achievements for ourselves, but if we don't get to the Olympics or into finals or get medals, then we don't get in the news. We [the men's team], I think we have everything we need, I don't think we need more investments, look at this gym I think it is one of the best in Europe. We also have physiotherapists, doctors… so I don't know what needs to change, maybe more coaches with a lot of knowledge. Not that our coaches don't have the knowledge, but themselves know that they should go abroad to get more knowledge, so maybe more investments in that. I am thinking about money, but that is not the reason why we do gymnastics, yes it is useful, but I don't think that we will do better gymnastics because of that. Maybe we then could do school at a slower tempo, so that we could train a little bit more, better, and more efficiently. And maybe we could do gymnastics for a longer period because now

a lot of gymnasts retire when they are 24/25 years old. Because we don't get money but we have to make a living. But what will really help, I don't know.

**Are there things that are not important and could be left behind? Why?**

No. I think it is interesting that is can be expanded to different markets, it is not only focused on gymnastics. Everything is very precise, that is not redundant, but it may be too strict. Oh yes and the app, I think it is unnecessary, I don't really understand it. Why show an animation, instead of the real gymnast. For me at this moment, I don't have a lot of information about it, it seems weird why you would see a simulation of something that is happening in front of you. When you what gymnastics is, you don't want to see the specific skills. I wouldn't recommend it to my parents. But it good be really nice for videogames.

**Do you think this technology will induce more fans watching/following the sport?**

For real fans I think they will like it, it will go faster if there is something they don't know they can find it out. But for completely new fans, if that is the only barrier to why they don't watch gymnastics, then I would find it strange why they aren't already a fan because then they would do some effort to try to understand it. I don't think that will help. [Céline: What would be other barriers?] That they just don't find it interesting, or yes that it is too difficult.

Nowadays European and world championships are shown on television, whether or not because of Nina, I think it is already getting better. [Céline: Do you think the more it is on television, the more people will watch it?] Yes, if they talk positively about us, and that they don't take us down constantly.

**Would you have problems with no judges anymore and only the technology that evaluates?**

For me, as a Belgian no, but maybe Japanese and Chinese gymnasts yes. Because they get more advantaged by judges, and with the technology that won't happen anymore. And also in the first subdivisions judges are more strict than towards the last subdivisions where they are less strict. With the technology, everyone is evaluated the same. Now as a country, we can have some stress for the drawings of the subdivisions. If you are drawn in the first ones, you know it is going to be difficult, and now it will all be the same. It shouldn't be influenced by it, but it does, everyone in gymnastics knows that. For example in Stuttgart, the Germans were in the last subdivision, the other countries competing with them were punished more, just because Germany was in that subdivision and it was important for them to be in the top 12 to go to the Olympics. And that was very obvious! There is too much subjectivity and that is known by everyone. Especially with the subdivisions and the friendly countries (vriendjeslanden). Like we also see that, when we go to an international competition in The Netherlands, we know that they will help us. When they see a Belgian or a Dutch in comparison to another nationality, they will judge more harshly for them, and just normal for the Belgian or Dutch.

**What do you think of the artistic aspect?**

I think that for those gymnasts who bring their own touch in their gymnastics, it is not good. When it is done with human judges, they would sometimes give an extra tenth, or deduct less because it has a good look and it is beautiful to watch, while machines are machines, they don't think and don't have feelings.
I am very curious about the technology! But if for now, they only use it for the D score, the problem of subjectivity will remain, because it especially happens in E score. But it is very interesting.

*4. Noah Kuavita*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is positive because everyone will be judged the same way. And I think it is good for the viewers to follow what is happening, I think it is interesting for them to know things such as the height.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The disadvantage is that these are robots, and don't have the human touch. When you do a skill and you do it a little different, they will still give you the value of that skill, the technology would maybe not recognize it or not value it.

The advantage is that the competition will be quicker, so you will also be able to do more on a competition day. And also that everyone is judged the same. Nowadays we notice that the top performers are judged less harshly than sub performers because they have a name and they are popular. Sometimes if an American had done a routine, it would have gotten a better score than if I would have done that same routine. Because judges know that they are from a big country. There are multiple examples of that, at the world championships in Doha (2018) for example, the American on rings. And also Petrounias at worlds in 2019, he shouldn't have been in the final, but he still got enough points to get into that final.

**What impact could this technology have on training methods?**

Yes, I think so. At the training, we will be able to see the angles and it will be easier to improve on that. Here we have the Smart Rings that measure the time you hold a position, we have them for a few months and it is really helpful.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes, I think so. I think that everything has its advantages and disadvantages. If they are going to automate everything, the judges won't be needed anymore. But it will help the judging to be faster.
For the audience, I don't think it will make a big difference. Yes, they will be able to follow it easier, like with the app, and then also that it will take less time to watch a competition.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, I think so. I think it will get more interesting for non-fans and it will attract them to watch the sport.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think that should be more spectacular, more like a show. And also the longevity of a competition, that it should be shorter and more pleasing to watch. The media attention has increased the past 2 years but I think that it can be better, but it is difficult because we don't have competitions each week, we can't come into the news each week. It is better, but it could be even more. But it comes from two sides, if there are more accomplishments it will be more in the news and on television. [How could you achieve such accomplishments?] An even better system, a good program, and enough coaches. A bigger team around it and also some more financial aid. Especially for the men's team, there is not enough financial aid. I am lucky because I am at the Belgian Defence and I get paid, but the other ones they train here for 10 years and they get virtually nothing. They pay our physiotherapists and doctors so that is great, but we cannot live from our sport. And that could help improve the results because it means that we can stay longer, and the older we get, the more experience, the better results we can get.

**Are there things that are not important and could be left behind? Why?**

Not really.

**Do you think fans find it important to know how the scoring works?**

I think so. The more information a spectator gets, the more interesting it is for them. Otherwise, they see a routine and then they see a score, but they don't know where that score comes from. Only the big fans and the experts know that. So if it gets explained, more people will understand it, and that could lead to more interest in the sport.

*5. Jonathan Vrolix*

**What is your first reaction after seeing this video and being introduced to the technology?**

I knew that they were occupied with that technology, but it is cool to see these explanations, it is really interesting. It is crazy that they can see everything perfectly. It would be crazy if this becomes a reality.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

An advantage is probably that it will be more objective, and there will be less discussion. For example, sometimes we think that Chinese gymnasts get favored, or the fact that there is an advantage or disadvantage of being in the first or last subdivision, so that could disappear. It is not a big problem, because that is how our sport is, there are always disagreements and there is a bias towards some countries, so in itself, it is not abnormal, so that technology would make it fairer. And it would be less

subjective, but in the end, it is a jury sport, so it would take away the basis of gymnastics. [Céline: Do you mind that?] That is difficult, in soccer for example there is the VAR, I thought that would be great, but we see that there is even more discussion than before. So now I think there won't be a discussion anymore about the judges, but about the technology. But for the D-score I think that it would make things easier, because to me it looks pretty conclusive, and not susceptible to a discussion. But for the E-score I have some questions, every athlete is different, has a different body type. And gymnasts who haven't the right body type will probably be punished for that, which is not fair.

**What impact could this technology have on training methods?**

You know even better on what judges focus because you have a judge in the gym with that detail. We will focus more on details, and I think we will train more smartly and efficiently. For example, if you see a gymnast do something and you think it is good, it looks fluent, but that the technology would point out the errors. So maybe it would be easier for coaches and gymnasts, if the system says what you are doing wrong, you don't have to find out what is wrong.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes, I think so. I think the gymnasts would have the most advantage because the sport is done by gymnasts.
The advantages for the fans, if they can see the height of the jumps and how long you hold a position, I think that for fans that don't understand it well, that that would make it easier. I don't think much will change for the big fans, these statistics are nice, but everyone knows that Shirai twists very fast or that someone jumps very high or is really strong. But I think for people that don't really understand gymnastics, or that don't see the difference between 3 or 4 twists, that it could be an added value to understand it better.

I don't know if it would attract completely new fans, yes I think, I don't know how, but yes probably. Gymnastics is a difficult sport for people who don't understand it, so that would make it more understandable, so yes I think so. So maybe if they understand how the scores work, they would rather see it. Because when you see something as a layman you think something is great but then you see a bad score and they are like "I don't understand this, why would I watch it" so this could make them understand more why that score was given.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

Difficult question. In any case, being more in the media, like Nina for example now, then more people know you and they get interested. But therefore you have to achieve results. So I don't know. I think that a reason why soccer is so popular is because it is easy to understand, and gymnastics is and will stay a difficult sport. You hear from a lot of people that don't know anything about it, that they find it a beautiful

sport but eventually they don't follow it. That is because you have to do an effort to follow it, while soccer is always and everywhere. For example, for gymnastics, you have to type in 'gymnastics' on the website of Sporza, while soccer is everywhere on the site.

I also think that the atmosphere at competitions could help. I often go watch soccer in a stadium and there the atmosphere is much more crazy and fun than a gymnastics competition. For example, when I was watching worlds in Stuttgart, that was equally as good as a soccer match. But at small competitions, it is just not very crowded. Like at the Belgian Championships, no offense, but not many people come to watch it, so it is difficult to create a nice atmosphere. But it is already better than before thanks to the performances of Nina.

**Do you think this technology will induce more fans watching/following the sport?**

I don't know if people who are not a fan, suddenly will be induced to watch just because of that technology. I think that if it comes more in the media, that it would have a bigger effect on non-fans, than this technology.

**What do you think judges will think of the technology?**

I don't know. I don't think that a lot of judges will be enthusiastic, because if this technology comes through, the judges will be redundant. I think that most judges prefer to do E-score than D-score because D is logical and clear, well they can also sometimes be wrong, so maybe for the D score the judges won't make a problem of it, but for the E-score they will. But for me gymnastics stays a subjective sport, there are other jury sports and I think that that unexpectedness like "wow he gets a big score, or just a low score", that can sometimes be in your disadvantage, but eventually I think that is the beautiful side of gymnastics, that emotion around it, so that could disappear. I agree with fewer judges because there are too many of them, but for now, I think judges for the E score are still needed, and maybe in the future, I would agree with no more judges at all.

*6. Dorien Motten (written)*

**What is your first reaction after seeing this video and being introduced to the technology?**

Very positive! This could bring big changes in the gymnastics world.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Positive is that a computer is absolutely objective, the judges aren't that at all. Judging in gymnastics can be very frustrating. You can't compare any competition in scores, at one competition you perform a good routine without a fall and get 11.6. The next competition you perform a routine with a fall and get 12.4, this is kind of ridiculous. The difference should never be that big and that obvious. The objective computer could bring change in this. On the other hand, there is still the human aspect, especially on

floor exercise. There it is important that you bring over emotion to the judges and the audience in your choreography. A computer cannot perceive and evaluate that.

**What impact could this technology have on training methods?**

It could be useful to watch and analyze skills that are difficult to succeed. Sometimes the corrections of a trainer can be difficult to interpret by gymnasts. With this technology, the coach can show precisely what he means.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes, I agree for the reasons mentioned here above.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

More media attention! And a possibility to earn a wage with gymnastics so that you don't have to do a fulltime job next to it in order to be able to live. There is also a need for more elite training centers for senior gymnasts in Belgium, not just 1 central place. This way as a gymnast you can train where you want and with the coach that accompanies you the best. Every gymnast out of any center should get the same chances to be selected for international competitions, world cups…
More media attention and a better atmosphere at competitions could also be a good thing.
**Are there things that are not important and could be left behind? Why?**

Nothing I can think about right now.

**Do you think this technology will induce more fans watching/following the sport?**

I think it is interesting for people who don't know a lot about gymnastics. If they can show skill with their name and their execution, they have an image of it, and those weird names (such as Tsukahara, Tkatchev, Shaposhnikova) won't sound like Chinese anymore.

**What do you think judges will think of the technology?**

There will be pros and contra. Those that like to judge gymnasts based on their reputation and nationality will have difficulties with it. Everybody knows that the Americans for example, get all their skills credited. It doesn't matter how bad these are executed. That applies to every gymnast who ever got an important medal or who has a famous name. The technology won't do that. If a skill is not executed well, it just doesn't count, it doesn't matter which name you have. Judges who judge as objectively as possible will be in favor of the technology.

## 2.2 Coaches

### *1. Matthieu Zimmermann (written)*

**What is your first reaction after seeing this video and being introduced to the technology?**

It seems to be a very complicated technology.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

A positive thing is that the speed of judging will increase, it will take less time to have a score. There won't be errors anymore with scoring, humans will make more errors than the machines. There aren't necessarily a lot of errors, but the appreciation of one judge to another can make the difference, and also the position of the judge that influences the angle on bars and around the floor. It will also allow precise analysis of a routine or skill at trainings.

Negative is that there is no appreciation of the quality of technique and of the artistry. The skill will be credited in function of certain parameters, like is it in line and well-aligned.. but for the trainer and gymnasts, there is no taking into account of the used technique (well, I think). For example, if there is a full-in done whether it's with the head back or not with a stuck landing, the machine will credit it (like a judge) but it won't help the trainer or gymnast.

With this technology, there won't be judges anymore and the artistic and spectacular aspect of the sport will go away. Because everyone will want to have the maximum of points to win and thus it is better to do less difficulty very well than more difficulty with errors. Only a handful of gymnasts will be executing difficulty perfectly.
Another negative point is that the morphology of some gymnasts can favor them. Today with human judges it already happens indirectly. A tall and slim gymnast (such as Nina Derwael) is more appealing to watch, especially on bars than a small and stocky build gymnast. But this is very subjective because every judge has its own opinion, and normally it cannot influence the score. On the other hand, small gymnasts can have difficulties with vault and pommel horse. A tall and slim gymnast has advantages on pommel horse and disadvantages on rings. It is biomechanics. For example, a double layout on floor is more difficult for tall gymnasts, than for smaller ones.

**What impact could this technology have on training methods?**

The techniques will be learned based on the technology and not based on possible evolutions. For example for girls, a Yurchenko layout has to be done in extension to be credited in a laid-out position (according to the CoP of the FIG), but in the learning phase, the summersault is done in a hollow position to be able to do a twist thereafter. But a summersault done in a closer position is validated as a piked summersault by the judges. So if the machine is strict with the code, it won't validate the position at trainings, but we will nevertheless use the video and the points to analyze the skill. There will be a stricter work based on angles, positions, landings… which will take a lot of time at trainings. The general level

will decrease and only execution will be important. But the Code of Points will be known by everyone, so it will be up to everyone to make the choice to be the most competitive as possible.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts and trainers, the technology will help in some parts of the training, for example before competitions or when learning a new skill or combination. But we cannot only work with that because there are many more things to learn before getting in those little details, and we unfortunately never have enough time.

The judges will have additional stress to not make mistakes and be as correct as possible. This may not accelerate the scoring process. The scoring process can depend on the competitions, be slow. This can have different factors: the judges are too slow, a discussion about a score between the judges, the ICT system isn't on point or is not mastered well enough bad organization… In addition, I don't think that replacing judges by machines is a great idea, especially in a sport which should stay a hobby for the public.

For the fans, it could be interesting to follow and understand the competitions. But it could also become a game where novices only see numbers instead of the gymnastics.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

There already exist some competitions that are really popular such as the Bundesliga in Germany, the top 12 in France, in college gymnastics in the US they fill arenas of more than 20.000 people every meet [which is almost every weekend in a season of 3 months]. Gymnastics can be popular if the country in general has a sports culture. The mediatization of events coupled with this technology will certainly be able to make gymnastics more popular. For example through interactivity with smartphones and the internet, through live broadcasts so that it can touch a bigger audience who isn't at the event.

**Are there things that are not important and could be left behind? Why?**

From a fan's point of view, the angles of 0° or 1° are very superficial, while it is the judge's and the athlete's job to attain perfection.
The writing of the symbols in real-time is really good for the judges but not indispensable for the trainers and fans.

*2. Ward van den Bosch*

**What is your first reaction after seeing this video and being introduced to the technology?**

It's fantastic.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The judging will be more objective, for the trainers it will be good to analyze better. The negative thing is that every little error will be detected.

**What impact could this technology have on training methods?**

Making more detailed analyses.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes for the fans. I think it is good for the fans that they show how the score is built. It will make it more understandable because this a problem, it will still be difficult, but maybe a little bit easier.

**Do you think this technology will induce more fans watching/following the sport?**

I don't know. I think that it will make it more understandable, but I don't know.

**What do you think judges will think of the technology?**

Well, their job will become unnecessary. If it works well you won't need judges anymore.

**What do you think of the artistic aspect?**

That artistic aspect is not important in men's gymnastics. The appearance is important. But it is all about the stretched knees and arms, about the angles and the rotation. I think it is good that everything gets measured very precisely.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

Shorter competitions. The big audience doesn't understand the sport and will stay like that. So easier regulations/rules, like a dual format. In Germany, they have such a system [Bundesliga], but we cannot do something about that. Although, it could be possible with duels. The point system can be kept, but there should be other competition formats. I don't think there are other things. It should just be clear to the audience who is winning, I even can't always see it with girls, sometimes I don't understand why one gymnast gets a higher score than another gymnast. I understand it with men's gymnastics, well almost. In the Bundesliga two gymnasts perform, like a duel, they both get a score and the highest score wins a point for the team, it is 0-1. It is much more understandable for the spectators than to understand a 0-1 than a 14.333

*3. David Spagnol*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is certainly a step forward for fans, spectators, television so that is really good. For the gymnasts, like us we do very precise and clean gymnastics I think it could be a bonus. But it is always difficult to think that it is the technology that will help us. We do artistic gymnastics, it has a soul... I am not saying that the judges will disappear, but when you look at soccer, they have video and it hasn't really resolved the problems, but it is different. Either way, trying and seeing how this will develop, I think this is a good thing to do. And it will take away that reputation of gymnastics and figure skating with judges, being subjective. So I think that is good. But I want to see it. And it will be at big international competitions, it won't have an impact on smaller competitions. So judges will still have to be able to come up quickly with a difficulty score. We will still need good judges, for me the technology is a bonus. At Stuttgart they used it for vault to see if the feet were out of bounce, these things are straightforward.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The advantages are that it will be more precise, it will be good for the angles. Take the example of Nina on bars for example at the world championships, we watched two days of competition. There were routines that had almost the same score as Nina, which is incomprehensible to me. I think that with that technology, it will highlight the gymnastics we do. It is good for the angles and the quality of execution, it will put us forward. Technically, I think we are above average.

For me, the disadvantage is to lose the human aspect which I like. AI does the work for you, it is good, but the relation with the judge... Yes, the judges should get better. But globally I don't know why it should be a disadvantage for us. If it is as good as shown in the video, then yes. But when you take the example of soccer, it's not really it. Before they said it was the fault of the arbitrator, know it is the fault of the arbitrator and the VAR, so it's even worse. And being a judge is also a performance. If at the world championships the machine can come up with a D-score in 5 seconds, it won't take long for the judges to disappear. But on a daily basis, we often do tests in the gym, we will never have that technology. The judges will always be needed.

But for the spectators and the image of gymnastics, to make it more dynamic and attractive, with less waiting time, I think it is good. We are in our sport, but when you ask someone who isn't in the sport, to watch gymnastics, they have to be patient. And when they indicate you.. like for example McKayla Maroney and her height on vault which is a lot higher than others, or Kenzo Shirai and the speed of his twisting, this is information that is good. Tennis already has it with the Hawk-Eye, the speed of shooting. Even there the judges are there to say out or in.

**What impact could this technology have on training methods?**

I would say for high-level elites like Nina or the seniors, yes because they have some time to do analyses. For me for the juniors where we do development and creation of performance, we are on a

higher rhythm of performance. I think that just taking your phone to make a video is already nice, we have a lot of information through this. We already have the televisions on which we can re-watch performances which is already very good. But for seniors like Nina where you reach for every little point the technology could be great. For the boys it is different, they have another way of training. I think it is more adapted for their rhythm of training. They have more time, from my perspective they will take a turn, analyze for 3-4 minutes, and then take another turn, they have more latency time. They don't work the same way girls do, maybe less intensive. They sometimes train longer, but not necessarily more intensive. So at trainings, I would say yes for the highest levels, for lower levels, I don't think so.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

The judges will take the most advantage of it. It is made for them, the detection of the angles, is it completed or not, do you count it or not. For the trainers yes it will have an impact, if it validates that it has been done to the handstand like for Nina, I repeat it because it has really shocked me at Stuttgart, then yes it should put forward the well-performed gymnastics so it's a bonus for the trainers. At Stuttgart, there were gymnasts who weren't as clean as Nina and still had big scores. And you really saw the difference with the Belgian team, we should have had better points on bars, also for some other teams in that first subdivision. But then it has exploded when the British all had above 14 on bars which I don't agree with. It is because of the rhythm of the two days of competition that the judges are tired. Or also because there are some expectations, for example Belgium is one of the best teams on bars, maybe even the number one, so you watch them as a number one, sharper. Sometimes there are countries such as Great Britain, they had Downie also... I think sometimes the expectations get mixed. And so that technology has no soul, no soul thus no influences. But you have to be sure that, I will again take the example of the VAR, depending on the place you are or the way you are looking, you have another perspective. When we say that the machine is placed at the same place as the judges, then they have the same view, so then it is okay. But on floor there are judges everywhere so it is not the same.

So I am pretty positive. I think that as a whole it is good, also for the spectators. But you have to keep the soul and the feelings side, how you experience someone. I want to see the technology to help the judges, and not to take over completely. Because anyways I know that it is artistic gymnastics and it has to do something to you feeling-wise. It is like Simone Biles on bars, it is done, but I don't like her bars because, well if all my girls did her bars I would be happy but, when I watch it.. well it is always a debate, she has some closed angles if it is captivated by the technology it should make a difference. At the time when you saw Liukin, she was the best, it was good because of her lines, and it does something to you when you watch it, I have never liked seeing 'brutal' gymnastics. There should be a special thing, an elegance. It is like Khorkina, Boginskaya, they had that special elegance. [The gymnasts you are naming here are all tall and slim..] No there are also smaller gymnasts who sparkle and give something. For me the idea is, that when I watch Flavia Saraiva, it does something to me she has that class. In fact, it is about that class, a robot that watches gymnastics, won't see such differences. That is why we have to

keep the judges, for me, there is an emotion when watching gymnastics. For me, a robot can't make that distinction, and they will never do because it is something subjective. That artistic aspect will always stay subjective. It is not about privilege, but it is human to say.. for example when you chose an element, I remember when there was discussion about combining the Derwael with the Ezhova yes there was a bonus, but the judges need to like what they see and thus it orients you toward giving a better score. It is not because the judge chooses to do something, it is because something happens and they liked it, and thus it puts you forward. It is like the Japanese women on floor, they really do it well, also technically it is good, but there is nothing special happening. I don't think that technology can't make a differentiation in this. I think the technology is great as a bonus, but I want to keep the artistic aspect it needs to be done by humans. Giving a score, it is not only about humans, but there are also specific things. It can maybe also allow the judge to have a different relationship with the work together with coaches. But for me, Fujitsu is a part of judging that can be added, but I don't want that our judges are robots now.

**Do you think this technology will induce more fans watching/following the sport?**

I don't think it will attract new fans. I just think that the ones that come watch gymnastics, not regularly, but they have something with it, I am sure that they will appreciate it more. [Céline: so just for the fans that are already existing?] No, not necessarily, for example, 2023 World Championships in Antwerp, it is sure that from all the spectators, there will be new persons who got tickets, or who got proposed to come to watch. For people who come to discover, the shock will be less big, like "I don't understand anything, why is it that long?". So I think it is a plus for such people who come watching. Especially like for example in soccer, well it has changed a little bit, people watch it often on television. So I think people that know how high a gymnast got is interesting, when you watch Simone what she does is already extraordinary, so I think it is a bonus. But I don't think that it will attract, but it will give more comfort to watch.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

The visibility of our sport, to get it more attractive, it is what is happening for us now, it is that Nina is world champion, the team has been selected to go to the Olympics for the second time. We see gymnastics on television. Gymnastics is a community sport, we are one of the sports, besides soccer and basketball, that is well developed on the internet, well developed on YouTube, Facebook, Instagram. So we already have that, to be more attractive we just have to be seen and get away from the clichés. For me making gymnastics more attractive is not the image that we make children work under pressure, like the old videos we see from China. We see Nina now, it is not about children that we make work with trainers that are grumbling and sitting. The image of the gymnast should be someone smiling. For me the technology, yes it is a plus for the judging aspect and that the scores are correct. But we need to get away from that image of gymnastics and figure skating because that makes me sick. But when going to a competition and I don't understand, I know that something is wrong. I remember for me Nina has three tenths more than her rival, even Sunisa Lee when I saw her at each of her turns at worlds, I don't have that 'wow' feeling. So for this, maybe the technology will make it more attractive.

But what has to change is the perceived image from outsiders and also the scandal from the US with doctor Larry Nassar, well that is exactly falling again in that negative perception. I am a trainer, I want that the girls are happy, that they enjoy what they do. But you can come to a training and you will still see girls crying.. that is because of the sport, it's not only gymnastics, there are other sports, we have other mentalities, you have to train really early and very hard. My son does basketball, you know it is not the same implication to train a lot at a young age. In swimming for example they train a lot, also a lot of hours, we have these similarities, we have a particular sport. To shine at the international level you have to be better than the others, but how are the other countries training? The Russians, Chinese, Americans, there is no other choice than to start early. We are senior at the Olympic games at 16 years old, at 16 in any other sport you are a debutant, well maybe not, but you aren't yet at the international level. So for me, making the sport more attractive is gymnasts that stay longer and that are more mature. We want our senior athletes to approach other senior athletes in other sports, increasing the average age of gymnasts.

The mediatization would also help. Our competition formats.., we don't have enough competitions with certitude, well we have our competitions of references like World championships and even the European championships now also because now we have an athlete that could possibly medal, so yes we can see these competitions on television. The English are ahead of this, the BBC broadcasts everything, if not live, you have it on the website, and oddly it is in a place where the culture has been established in gymnastics, so I think yes the access to the media can be a big plus, but for us broadcasting the Belgian Championships, I don't think there won't be enough appeal, it is too small. European championships yes. If we could have something like the Top 12 in France or the Bundesliga in Germany, or the Serie A in Italy that really fills big halls, that could be something to develop. We are working on it, it could be possible to integrate with the Benelux, we could to team competitions, but it is long term development. We work on it because we know it is a plus, and at competitions, there should be incertitude. For example in France, or the team final at world championships, it is 3 for 3 [3 gymnasts compete and all 3 scores count for the team total], that creates incertitude, if there is incertitude you look at it and you know there is a possibility you can win, you won't necessarily go to a competition and see Simone collect all her medals. For team competitions, gymnastics need to gain more importance, and for that, we need to work on relations with clubs. The girls who integrate the Belgian elite gymnastics team, we try to develop the image of their club. At Hasselt for example there will be a new gym through the influence of Nina, this is a result of that development. The Bundesliga fills halls, the Top 12 it doesn't work as well as it could, at the Serie A they changed the format and now it fills a lot of halls. They do two rounds of Serie A and then they do two Final Four that clash with duels, like the Bundesliga. I know that it can work, but the question is know which television could broadcast is? I don't know, but on the internet or a medium on the internet, I think it could work. At a certain moment, gymnastics has to be on television on other moments then when there is a world or European championships, and in that case, you will have more attractivity. I know that we have a lot of contact with television, they are here often and this way we gain more visibility, I think that this should be done. When the team has qualified for the Olympics there was a lot of return in the newspapers when France qualified for the Olympics, it didn't get that much attention. So these are advantages that we can get.

**Are there things that are not important and could be left behind? Why?**

No, everything I see, I know I like the idea. As a whole I don't take in negatively, I know that for the audience, for the trainers if it is not too complicated, it has to be easy and accessible for the trainer to use to not lose too much time, for the judges I think that it can be a plus. I welcome it positively. As I said if we stay in our bubble, the sport won't develop, we will have to try and see. It will start with gymnastics and maybe in 15 years, Fujitsu will expand to acrobatic skiing for example. [Well the rest of the video is about expanding to other sports.] I am sure that using that data to make videogames will work, once they, an expert in marketing, understand that gymnastics is a community sport, so you can consider other things like these games. It is sure that it will be a plus. I am not a fan of jogging, but each time I go jogging thankfully I have my app that says how much I run and how I did, so I think it can be very interesting.

*4. Koen van Damme*

**What is your first reaction after seeing this video and being introduced to the technology?**

I am an advocate of this system. It is impressive, here we also have a video system but that is completely different, here you just literally see the images. This is 3D, you see everything very precise upon the degree. It is incredible.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

For me an advantage is that the competition can go by smoother, now the competitions last two and a half hours. But there is also a disadvantage related to that, we have to do six apparatus, ten skills per apparatus within a certain time, so if the competition lasts shorter then I think it would be very difficult for the gymnasts to have the same performances if they have to do it within one hour instead of two and a half hours. For the television and the media, it is fantastic, it is the best they can have: an action followed immediately by the score. You could even do live judging, it isn't mentioned in the video, but the E-judges could immediately type their scores. And then you immediately have the E and D scores after the dismount, so you can immediately give the score after the routine, there won't really be waiting times anymore unless it is created by the media. But I am thinking that if a competition is over in one hour, how the gymnasts can bring the same performances, I don't know because now they have these resting pauses of 25 minutes between each apparatus, so that is a possible disadvantage. Also that the competition is spread over multiple days, well they could keep that like that, it will just go faster. But they could do the qualifications in one day, and podium training also. So this is an advantage, but maybe they will have the change the aspect of the CoP on that because you are speaking about impact, if you have to do that much impact and you have less time to recover for the next apparatus, it cannot follow each other too fast. The fluidity also has a disadvantage, maybe they should change the code then if you do eight skills instead of ten, that could already be a solution. Now you can see that gymnasts are quite tired for the dismount if they then have less time to recover for the next routine. They then have warming up, routine, warming up, routine.. it will go so fast unless they figure out another concept of

competitions. So I would say adapting the code, if you have done a heavy floor exercise and ten minutes later you have to do a pommel horse routine and have had warmed up, then you will also have to train differently.

The negative thing is that it costs a lot. The countries that have a lot of money will have a big advantage to train with it.

**What impact could this technology have on training methods?**

In the preparation period, you will analyze a lot more on how the skills are built, you will work more analytically. This is what we are already doing with simple images, but with this, we will be able to go much deeper, you may even be able to see the dynamic of an apparatus. For example, for a Kovacs or Tkatchev summersault on high bar you have the pull the bar in a certain angle so that it can react and pull you to the other side of the bar with the rotation of the gymnast. We will be able to see such things a lot better. And if the competitions go faster, we will have to adapt the training, otherwise, we won't be able to get through a competition. Se we will have to do trainings of an hour for six apparatus, that's ten minutes per apparatus for warming up and routines, that is hard. They will have to change the competition format and the CoP, it is such a big change. A routine without a fall, if there is a fall they give 30 seconds rest, lasts 40 to 50 seconds, then getting a score takes that same time or even longer, so the competitions are double so long. So it is a big change. And also, the CoP is written in such a matter with degrees and such, maybe they will also have to write it differently. I think that the scores will be lower and that there will be few elements that will be worth it, if they really measure everything, the angles, and rotations, so precisely. So they could work with margins, but then you diminish the sense of using computers. For example, the machine could say that you can deviate from ten degrees. For example for Noah at this cross on rings, they saw a deviation of six degrees in one arm, and eight degrees in the other arm, so that is within the ten degrees, while the cross looked close to perfect. But you also have the muscles and an arm has a certain thickness, it is not a fine line, and you have a body hanging in between so it is not that easy to see these things. But for twists on floor to see if it is fully rotated or not, that is insane.

You can also perfectly see if the value of an element is worth performing it in a routine. For example, if a 'Quast' has a deduction of three tenths, it isn't worth doing it because it is has a C value of three tenths. So per gymnast, you could have a database of the elements and see where and how much deductions they have, and you can perfectly predict the score of a routine.

**What impact could this technology have on judging?**

Well it would be a shame that you have such a system and that the judging of the judges doesn't change, or they could say that they do it without judges that is also a possibility, but what is a stretched toe and whatnot, I don't know if that is possible with the technology, probably yes. But it would be good that if a judge does live judging, thus it has a system on which it can type its deductions, that they don't have to look at the degrees, then I think that you have something that is accurate. Because now, at worlds they

did a test of the D-scores from the apparatus they could do, and they found that 94% to 95% of the D scores matched what Fujitsu had predicted. So it is about for example on high bar if you have to do something to 45° and you do it to 46° or 45° then it is okay but a judge sometimes it will credit 44° and sometimes it won't credit 46°, it is almost impossible to see, so I think that the margin of error, you would think that it is judged well, but 5 or 6% that is still quite a lot. So it has to be the same for everyone and the technology will help that. Some things happen so fast that you can almost not see it with the naked eye.

Gymnastics is and will always be a sport of judging. We see that some routines with some errors pass more easily than routines we do, but it is a bit Calimero, maybe yes maybe not. It is more objective than before. And it is not easy for judges, they have the CoP where everything is described, for some skills you have to take account of 5 different aspects, for example, a simple full turn on high bar, you have to look at 3 different axes, the body shape.. and if there is a good gymnast and he does that quickly, and you analyze it afterward yes than it is possible that he got 1 tenth less of a deduction. But yes you have that Russian clan a little bit, but yes.. I think it is already much better than before, I can live with it now. There were Olympic Games where the podium wasn't right in my opinion, but it is my opinion. Maybe that 99% of the gymnastics world thought it was right. It has improved with the supervisors and the dropping of the lowest and highest E score. And also for the Olympics they make a classification of the judges, who falls out a lot and who not, so it is a lot better and it isn't such a big problem any more than 10 years ago. But it could be even more objective with the technology.

Judges are not paid for their jobs, they do that as a hobby because they are also fans of gymnastics. They can be a fan of a specific gymnast and therefore subconsciously be less harsh. They admire some gymnasts. I don't think it happens un purpose, but the fact that they look up to some gymnasts surely influences them. Maybe if they would get paid, the judges would be people that aren't such fans, and maybe then it would be more objective. I don't blame the judges, because I think it primarily happens unconsciously. The technology will certainly avoid those influences.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

The judges not because they become less important.
I think it is especially important to sell our sport. For the fans it is great because they immediately have the score after a performance, they don't have to wait. The competitions will last less long, now sometimes a competition lasts two and a half hours, with that technology you could be done in one and a half hours. Nobody or not a lot of people are watching television for two and a half hours to watch 6 performances of 1 gymnast and to support him. It is a difficult concept. Cyclocross lasts one hour, soccer is two times 45 minutes I think that in terms of media that this is the limitation of our sport. Urban sports are coming up strongly because it is fast and spectacular and this is how society has evolved. So I think if you want to sell a sport better, this is very important. A sports competition of more than one and a half hours is too long, and that is the problem of gymnastics.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, I am pretty sure. There will be more explanations available, they will also more understand why a routine is difficult and why not. If the computer says it is a triple twist perfectly rotated, plus this... Then you have the symbols, yes that stays for the experts, but people will more easily follow what is happening. For example holding a cross for two seconds within the margin, perfect. It is clearer. Sometimes, and I see myself as a specialist, I also don't know where all the deductions come from, one judge deducts for this, the other for that. So yes the competition time and the clarity will be very positive for our sport. Because it is spectacular, but it lives under the radar. And here there is a certain thought that you can't cheer for a gymnast. If you go to a Bundesliga competition then, they have another competition format, it doesn't last very long, they work with duels, it is a party, the audience is drinking beer and making noise, there comes a lot of people to watch. Here we still have the perception of a gymnastics competition that lasts 3 hours on a Sunday and you bring the kids and everyone is like "shht, be quiet". Well, this is missing and I think that this could help to get away from those long-winded competitions that it moves forward, that it is done within one hour, and also for small kids competing that you are done with your competition in one hour, great and well done. It is the same as with soccer, if it doesn't interest you, you can quickly go to the bakery and you come back. It could help that it has a better atmosphere, for the parents, the fans.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I haven't thought about it. The media attention is only there if big performances were achieved, but it is like that in every sport, except for the popular, accessible sports. I don't think that the fencers say that their sport is popular. But I think it could help in itself. I think the most important is to shorten the competitions and to create a better atmosphere than can be with music, that it becomes more a show. Everyone comes to see the Gymgala, it is completely sold out [3 days at Lotto Arena], and then you have the Belgian Championships where there is better gymnastics and there is nobody. So shows and demonstrations, everyone likes to see it, because there are no silent moments, you don't have to wait for scores.

**Are there things that are not important and could be left behind? Why?**

No.
I think that the app is a great idea, for at trainings for example so that you can see the axes. You can really make a good analysis of the movements at trainings. The app is interesting, now we have a video system and it doesn't work well for a 100% and that annoys me, I can imagine that if that is developed, it will be from another level. I know that a lot of people are working on it, it is a billion euros business, it is revolutionary. Also in judo and diving, it could be perfectly used, in so many sports. It is very nice, that technology, you can't hold it back, you can do so much with it.

**What would you think if there were no judges anymore and only that technology?**

It will take the charm of the sport away. It is what is happening with football with the VAR, Fujitsu's technology is even more objective. But no I wouldn't have a problem with it, I don't see disadvantages. The artistic aspect is less important for men's gymnastics, I think that the charisma will be difficult to measure. You can execute something beautifully, and you can execute something within the lines, so there is a difference with it. Earlier the men did more things like a back walkover and splits and such, but now it has all evolved to acrobatic series, without many frills. So it isn't that important for us that there won't be judges anymore. For me personally, there is no problem.

*5. Marjorie Heuls*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think that for the training, for the athletes, it is a good thing. Also for the spectators. For the judges, we have seen the limits of the computer, if for example if a gymnast has to do two turns, and she does a little less, the computer wouldn't take it, while the human would give a margin of errors. So at that level, I think that they have to adapt a little bit. I think that for the judges, at the actual state, it should be a supporting tool and it cannot replace everything, this is why that that small margin error.. a judge can see that if the technology says that it is 856° well than the judge can tell if it has a difference of 10° and can then accept or not. I think it is really a great thing for the audience, I think it can really give back some interest to our sport because it is always difficult to understand for people. And with this it will open new perspectives, the people may get more interested in the fact that they better understand the discipline and the judging. The fans, in general, are interested and passionate so they know already some things. I think it is more for the audience who is interested in it, those that for example watch it when it is on television, rarely… and that also for the TV channels, it is a sport that is more measurable so I think it will create more enthusiasm to broadcast it on television with this system.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Well for the training methods, we have already evolved into the video system. When I started at INSEP we didn't have the cameras and televisions at training. And with this system it is very interesting for the autonomy of the gymnast, and also for the relation with the coach because when it is the coach that says something, it is understandable, so having the instruction and the image, I think we win a lot of time on the understanding. And I think now with the 3D analysis, and the points of the joints, because gymnastics is a lot of work with curves and such, once there is a movement that is too angled for example it is easier to identify with this technique, so that is really interesting. The better we know the bodies of the athletes and are able to adjust in real-time what they did, the better they experience these things. So that is it for the advantages.

For the judging it is to go to more objectivity, on the other hand, there are the artistic aspects and other aspects. But I think that in any case, if it becomes a judging tool, the evaluation of our sport will also evolve. For example, the height will be quantified, on a release for example, or a jump. I think it will also help to be more correct in certain aspects. The errors that happen are human errors, when the judges

have to judge an entire day, for example on vault, at the end. Well, it is normal to not have a very good vision of what is happening and to have a good evaluation, so I think that with this tool it will be easier. Even if they have just have it as a support when something was missed, we have that to justify that they missed something, so I think that is great. The subjectivity of the judging is the evaluation of the eye, even us sometimes at the training, now that we have the videos sometimes we haven't necessarily the right assessment. There is no real voluntary cheating anymore, if there is subjectivity, it is more because of tiredness. These competitions last long, being attentive the whole time is difficult and there are also a lot of things to evaluate, so maybe on half of the things it could be the computer and the humans could concentrate on some more precise points, so it could really help. I don't think there is a lot of bias anymore, but it is sure that if you are a small country, you have to prove yourself, you have to be flawless to enter in the top 12. You have to convince with one or more gymnasts on the quality of your work, not only with one individual. There has to be a positive evolution, that the judges see that it is a profound work and not only one talented gymnast who achieves results, so yes you have to work hard to enter in that top 12. But there is always a little advantage.. but it is because you were good that you have an advantage. But sometimes on certain evaluations, you can tell that a judge was more tolerant than if it wasn't a gymnast of a certain country or with a certain name, but it is rare. I have noticed that the average level has evolved to higher levels, but between that average level and the high level, there is a milestone, and it is there that some judges are less flexible on some things.. You have to show that it is good, ones you have done that, you can have a little margin of compensation, but as a whole it is okay.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes, I think it is good for everyone. I think the gymnasts, coaches, and the audience will have the biggest advantages. For the judges it will help for the objectivity so yes it is useful, the more objectivity the better. In all cases, I think that the judging how it actually is has to be adapted, the CoP has to be adapted to the system. The system is built on the Code relative to the skills, but in terms of evaluation, maybe they will have to reassess certain criteria. If it is really objective, for example, I think there should be more difference between the degrees of the height, they can take off 3 or 5 tenths, so now if you really have the numbers of the height, then you can put the deductions in function of the actual height. I think that they will also have to adapt the judging so that it is related to the number you get from the technology. These numbers have to give you a deduction that can be more smeared, now there are fewer differences that can be done between a really high jump. in fact, you only have very low, average, and very high, and maybe with this, they could do scales and differentiate more the gymnasts. So in that sense, I think they will have to reassess the evaluation to optimize that tool.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think that it is the understandability of the evaluation, so that is a part of it. And then the problem of gymnastics is that it is a sport of risks, so to transform it in a show is delicate, because you have to offer

good conditions to the athletes and not put them in shows where we put them in danger. But first of all the comprehension of judging in bigger volume, I think that that could already attract more spectators. And then I think that doing more flips and twists, always demanding more of the gymnasts, I don't think that is a good idea, it cannot become too dangerous. Also, the outfits and the creations could be worked on. The atmosphere at competitions also has an influence. It is true that sometimes it can be long, but it has already become better, where there are more staging the entrance of gymnasts, in the breaks they do some animations for the audience so that has already changed, but this is at big international competitions. If we look at the Belgian level, there are not really club competitions with teams so there are no supporters of a team, it is mostly the parents and a little bit the club in the audience. In France it is different because there a team competition from to lowest up to the highest level, and automatically if you have a team, there is something created behind the club, there is an identity, in fact, you are a member of a club and you represent your club, people come to support you, and thus there is a better atmosphere. Here it is different. And Acrobatic Gymnastics is more popular than Artistic Gymnastics in Belgium. [Céline: really? Because it is less mediatized than artistic gymnastics.] Yes because it is not an Olympic sport, so the media are less interested, it is the same in France. Despite the good results they have here [in Belgium], because it is not an Olympic sport, it doesn't really interest the media. I think it is more popular because for example here in Ghent there are only Acrogym clubs, no artistic gymnastics club. I think it is a little bit the history and the culture of everything that is together, in a group. It is a beautiful sport and I understand that kids like it, because it is dance and acrobatics. The kids that are afraid of bars and beam they are probably going to try Acrobatic Gymnastics. And it is also because from the start they don't have the structures to welcome them. But I think that is developing now. In Wallonia it is not the case, there Artistic is more popular than acrobatic gymnastics.

**Are there things that are not important and could be left behind? Why?**

No, not really.

**What impact could this technology have on training methods?**

That technology would really be an added value at trainings. But I think it should be kept for the high-level gymnasts. Like here we have that video system, which I think is quite costly and which has not been optimized. We have 50 000 cameras [figurative] here but half of them are out of service. Fujitsu came here because they are looking for a gym in Europe to use it as a showroom kind of. When they looked at our gym and our system, I think they were quite interested, but they will have to talk about the financial plan. If they want it to be a showroom they should make a price, so I don't know if it will be done our not.

**What would you think if there were no judges anymore and only that technology?**

I think that we will always need some judges, you can always have a breakdown or something. And there are some nuances that the system cannot take into account, and that judges will have to do. And then also regarding the artistic aspect, the feelings of judges will be needed. For the rhythm of the

movement and the relation with the music, I think it is doable for the technology the measure that. But the emotions and expression, that is something else. But the rhythm and the richness of the movement in comparison with the originality, they could do it, in function of the movement of the arms and legs and body, if there is enough movement or not, or if it is too basic, that should be possible to do.

*5. Julie Croket*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think that is something that will surely be implemented in the long term. It is of course difficult for judges to take immediate decisions, so if they can have a back-up from such a system, that would be handy. It is also nice for the people so that they know what they see, but if you already know nothing about it, I think it is still too complicated, I think you already need to know some basics.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Well, the advantage is that it is accurate if the foot is straight it will be straight, and if it is flexed it will be flexed, and that machine will see that of course. So it will see more details, it will be more accurate than the naked eye. On the other hand, gymnastics is an artistic sport, so the choreography, the appearance, how the gymnast profiles itself, I don't think that the technology can judge that. I wouldn't know how to would manage to do it, it is pure data in fact. I am asking myself if the system also devaluates, for example, you do a jump and it sometimes gets devaluated by judges, would the system also do that, I don't know. If it does, that would be very interesting.

**What would you think if there were no judges anymore and only that technology?**

It is a tough question. From having been a gymnast myself I would find it weird to have to salute to a computer and that you don't have that personal contact with judges. For me, it does something. While if you salute to a computer or a camera, that is different. But maybe that the new generation of gymnasts don't mind it, I don't know. That human aspect will disappear.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Absolutely. If you could use that technology at trainings and do better analyses of skills and how to improve them, of course. Because as a coach you don't always see everything immediately, most of it, yes, but you can always improve on the finetuning, so that is, either way, a good thing to help us. For judges, it is their job, the computer will do their work for them, so that will be difficult for them to fight against that. For fans, it will make the sport more accessible in a certain way. But it will keep being complicated. So if they could give a short guide before that, then I think that it could be quite accessible. But at this moment... I don't know, I don't dare to say it, you will have to test that, I am curious.

**Do you think this technology will induce more fans watching/following the sport?**

I think that in any case, if you look at the ratings of gymnastics at the Olympics, a lot of people are interested in it, but drop out because of the fact that they think for example that it is a score out of 10 and 10/10 is perfect, and then they see an 11 and they think 11/20 that is bad. But that is not how it works, not at all. And if I try to explain it, they get an image of it but they get confused because it is complex to get to that number because they want to compare it to a point out of a total, and it is not at all like that. So maybe that program could help with that.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

More broadcasting time for gymnastics. On TV in itself, there is not a lot of gymnastics. Now with our world champion, there is a little more attention and people get more and more involved in gymnastics. But despite that, you see soccer every day and not gymnastics. Okay, it is different of course because you can't broadcast gymnastics daily because it is not daily, that is not possible. But they could broadcast more competitions, I think that will help either way.

I think that especially in big competitions there is a nice atmosphere, they really try to integrate the audience. And at some competitions they explain the requirements of a routine and how the evaluation works, so on that aspect, I think that they are putting effort to let the people understand, at least the basics. At little competitions, they don't really do it. And the supporters there are mainly the parents or persons who come to watch someone in particular, while at very big tournaments there are also people who are just interested in the sport, and not specifically come for someone. I think for the Belgian, Flemish or Provincial championships, honestly, there is not enough advertising about it. If they would commit more to that, I think that more people other than parents would come and have a look at the competitions. I don't know if they do a lot or not, maybe yes, but this is the only thing I am thinking about that could improve.

I think that we underestimate the number of people that are interested in gymnastics but just don't understand it. That is the thing that I feel when I am talking about gymnastics to my friends. They are interested in it, and when they see it they have that 'wow' feeling, they see that a lot of work has been done and that it is difficult. But they don't understand that when you land and take a step, that that is an error. They are just like "wow she landed on her feet that is amazing". And then there is a score and we would think it is not that good and they would be like: "come on that is great!". So it is mainly about the knowledge of gymnastics. Before it was with points out of 10, if you had a 9 it was good and a 7 wasn't that good. Now it is this plus this plus this, minus that and then there is a bonus… Even for the young gymnasts, it is difficult, and they are in it on a daily basis. And I repeat a lot how the basis works, it is just complicated, which makes it interesting, but you have to understand it. So I think that that technology is a step in the right direction if they can use it on television, that you get commentary on what you see. For example that you have to hold a position for 2 seconds, if you don't tell them they don't know, and these things are interesting for them to know. So I think that it can bring more knowledge to the people.

For already existing fans it will be great because they will have a better understanding. For completely new people, it will be a little more accessible, but I don't know if they see a screen with a symbol and a D-value, that they will understand what it means. Sometimes it is clear, but sometimes not, like on a bar routine the combinations from going up and down, what is what. They should have to stop the routine to show what value each skill has but that takes too much time and effort, and then you can't watch it live anymore.

**What impact could this technology have on training methods?**

The trainings will be even more detailed, it will also be easier for the gymnasts. They will focus on one skill and they can see where the error is, they will see it, they will see where exactly they get deductions, and then it will be more clear for them. I already do it, with the slow-motion mode on my smartphone camera, I also draw on it and show them the errors, but I have to do it all myself. This technology will show everything automatically, so we will be able to increase the intensity of the quality of trainings and you can also work faster.

**What do you think of the judging how it is now?**

It depends on which judges, I have no critique to judges, but there is a difference between judges that judge a lot, international judges, and judges that judge on a lower level (regional, provincial or national). I have to say that we have great judges. Either way, that system will help when it is implemented because it could work as an extra reference. It will also be clear, earlier especially nowadays it is still the case a little bit, you get a name, and then sometimes you get some gifts. It is always like that. Someone who is just entering the senior field may get more deducted than someone who already has some medals, I won't say that they sometimes close an eye because that is not true either, but sometimes they can get some gifts from the judges. So that will disappear with the technology, that is a given, it is a computer.

**What do you think judges will think of the technology?**

That is difficult, I am not a judge and I have never followed a judging course. Some will like it, and others a little less. Judges who have been doing this for a long time and know what they are doing will like it to have an additional reference point, judges that are a little insecure about what they are doing, or are just starting I think that will add additional stress for having the same score as the technology. I think in general it will be positive, that it can be seen as a helping tool. In any case, it will always be correct, they will have to test it, but I think that it will be accurate for 99,9%.

## 2.3 Judges

### *1. Tatjana Decaesteker*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is surprising what they can achieve with this, I knew there was some evolution in the setup of the technology, but I didn't know they had the idea to develop an app on which you can follow the competition, or on television, it is interesting, also for people that know a little less about it, which will

make it easier to understand the judging. For those people, everything seems the same, if you don't know anything about it. This is a progression, something interesting.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

For example for the app, people will constantly be watching the app instead of real life, from what's happening in the arena. An advantage for the judges, it can be a tool to help them, and it will maybe comfort them, because sometimes there is discussion if something has been noted or not, and afterward at some lower-level competitions, there can be a discussion between the trainers, gymnasts, and judges when there is displeasure about a score. With the technology there won't be such discussions anymore, which is an advantage. I don't know to what extent that technology is on point, because a floor exercise for example, to me it seems very difficult that such technology can evaluate that correctly. Everyone just does random things in different directions in all possible combinations, plus especially for the girls, there is that artistic aspect, I think that for such things human sense is still needed. But regarding value assessment, if it can recognize that, the technology doesn't necessarily have to decide it on its own, but that it can be a tool to help the judges. As an extra tool, maybe eventually it can be completely robotized, but I think that it would be good if there is still some human control. I think it could relieve some stress and be better for the accuracy of the scoring. Because now we notice that sometimes we ask ourselves, "was the turn or twist completed or not?", especially when the gymnast is on the other side of the floor, and then you judge in favor of the gymnast, but that is not always right. And sometimes we disapprove of something rightly or we give something wrongly, so the technology could make it all more objective. And also from outsiders, there is discussion if the judging happens correctly, you can give the points you want. Well, now the judges are evaluated too, and the lowest and highest score is dropped, this makes that the scores of the different judges are quite close to each other, also for difficulty scores, there is always a reference judge, so everything is controlled. But there can still happen some things behind the scenes such as cheating. So that technology will minimize the chances for those practices. Before it happened a lot more than now [the bias], especially because now there is more control, the lowest and highest score is dropped, there is a reference judge, everything comes on television, everyone can see everything, you can fill in an inquiry, so especially at high levels, it is limited especially in the difficulty score. I don't know if the technology will be able to do the execution score because that is very complex, but as a judge, you notice that when there is a gymnast with a name, like Nina Derwael for example, you know that she is good. And I think, even though you don't want to do it, unconsciously you judge less strictly. Because of the name, I think it plays a role unconsciously, with the technology you don't have that problem.

**What impact could this technology have on the manner of judging?**

Well, first of all, it will be more strict, more efficient, faster, because there will be less calculation done by humans. It will be more correct, accurate, there will be less discussion, everyone will know for sure that the score is correct. Sometimes it is like "she has won by 1 tenth, if you had put one more mark, she wouldn't have won", this is some critique we get a lot. The technology could reduce those

discussions, people will have more faith in it, and it will be more clear, so everyone will agree that the technology is correct. And what the technology has decided is correct and cannot be doubted.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For trainers, if they can use it at trainings it would be good, they could know what they have to expect from the technology, how the technology would judge a skill or routine. If they can analyze it, they can specifically see where exactly they have a lot of deductions, and they know if they work on it and it gets better, at a competition it will be evaluated like that. Now sometimes coaches don't know for 100% how something gets evaluated by judges or think that something else gets evaluated than how it is actually evaluated and then they are surprised why someone has a lot of deductions on a skill. So if the same system is used at trainings as well as at competitions, then it will be unambiguous.

For fans, it will be good to have a better understanding, and for the judges, it will make it easier and more efficient. So I think that in general, it has a lot of advantages to be implemented.

**Are there things that are not important and could be left behind? Why?**

Well the app may be cool, but I don't know if is necessary to look at it when watching a competition, I don't know if it is an added value. It is difficult, I think it could distract people from watching what is happening in real life. For the judges, I don't see something that could be left behind.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think that in itself, everyone finds it interesting because it is spectacular. But sometimes it is difficult for outsiders to understand. My boyfriend says that gymnastics is boring to watch if you know nothing about it, you don't feel that tension/excitement. You don't notice who is winning or not, when you watch track and field you see who runs fastest and you feel that excitement. If you know nothing about gymnastics you think it is nice and spectacular but you don't understand it. So maybe that technology would make the understanding of the judging more clear, but I don't think that it will make that people find it more exciting to watch. I think that that is something difficult in gymnastics because it is something very specific. To make it more attractive, sometimes it is too complex for the big audience. I think they have already invested in it to make the events more fun, but I don't know how you could make it more attractive to outsiders. I don't think that because there is that technology, more people will be watching the sport. The people already watching it will understand it better and will have a better view of it. But I don't think it will incite people to watch gymnastics.

I think that showing how the score is made up will make people understand the score more, but I don't think that non-fans will follow the sport because of that. Because from itself they will never understand how it works, they will have to wait for the explanation and be like "okay, well if they say so, that will be

it". If such people watch gymnastics, they don't realize how difficult something is, they don't have such feeling. With tennis it is easier to see what is happening, you don't have to wait, you have that excitement immediately.

Well, we can notice that the successes of one person or a team already does a lot for the attraction. Also, the media is very important, because it comes more in the media and on television now, we notice that more people are coming to events. I think that the nature of the sport makes it difficult to attract a big audience. A lot of people only watch gymnastics at the Olympic Games, because it is the Olympic Games and the whole experience and framework attracts people. And for these people, it is just ones in four years, and it is the best of the best that they see, while a world championships are equivalent regarding the level of performance.

*2. Iliana Fegya*

**What is your first reaction after seeing this video and being introduced to the technology?**

I have already seen this video. For the gymnasts, it is good to know how their positions are, the height, the errors. For the judges it is good, I study visually, when I see skills, it is easier for me to see the skill with the difficulty value next to it, this way I can visualize it, especially for skills we don't often see. For the viewers, I don't think it will interest them, spectators only watch the best gymnasts competing, or only watch gymnasts from their country. I don't think it will interest them to know the height of a gymnast. I think it is more for the 'specialists' the gymnasts, trainers, and judges. It is good for them that they can watch their height, their angles, posture, and form. I think it can also be interesting for the fans that already know a lot about gymnastics. I don't think parents for example will find that interesting to know, they even don't really watch other gymnasts than their own kids. Even we as judges, when we watch the world championships, we only watch the Belgians, and the strongest teams, we don't even watch the weaker teams.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

For me, this program would be good for studying for the judges. I think that is interesting for visualization. But for geography, I don't understand how computers can judge that. Even with us, the human judges, we don't have the same vision. For example, I like more classical choreography. For example, there are judges that think Simone Biles' choreography is very static, well I don't have that opinion, I think that she is a phenomenon she is exceptional, yes she may have some flexed feet, or her choreography doesn't correspond very well, but it was made for her physique, and for me, she is a bomb, I love it. Before, there were gymnasts than didn't do a lot of difficulty and also had that type of choreography on the floor, and I didn't like it. But because Simone is a phenomenon it is different. But the choreography is subjective, and I don't understand how computers can judge that, for beam and floor. On bars I have already seen such software and I think it is incredible, to see the angles, it is really well done. And for the execution errors, it will be very precise, it is very nice. Also for leaps, to see the height and amplitude

of Simone Biles in comparison to a boy, well it is equivalent, and it is nice that we can see this. But from an artistic point of view, I don't understand.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

The technology is good because there won't be errors anymore, from a difficulty value perspective. But the precisions for the leaps for example, will have to be put in the computers, I think that could be complicated. Like this year at the world championships, we didn't really understand the difficulty values from gymnasts on floor and beam. We found it weird, we saw that the experts had blocked the computers, so they didn't agree as well. There was also a lot of waiting time, which shows that there was some discussion about the scores. Maybe this technology would limit such situations for the D score. But for the artistic component and the feeling, I don't know. And also, will they still need us then? We study, we invest quite some time in it, we are asked a lot, we go to different places. If they start to only use some judges together with the technology, we won't be needed anymore while having been invested in it for years. And we really like doing this, it is our passion. We do this as volunteers, it is a hobby. In some countries, judges are doing this professionally, as their job, but here it isn't the case.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

Well, for example, thanks to Simone Biles, a lot of people begin to get interested in gymnastics and know Simone Biles through social media. Even for Nina Derwael, I know people who don't know anything about gymnastics but still know who is Nina Derwael.

There should also be more resources for the gymnasts, except for Nina thanks to her performances and results, but the others don't have a lot. It is not mediatized, not very often on television. Because first of all there are not enough results, thanks to Nina it has bettered. When we look at tennis, there were some results with Kim Clijsters and Justine Henin, and now there is money, there are sponsors. The better the results, the more sponsors will get interested and then we will talk more about it on television, and it will get more mediatized. Thanks to Nina there are a lot of new gymnasts in the whole country that get into gymnastics. Parents, friends, and family get more interested in gymnastics. But otherwise, it should be better compensated for gymnasts, because they get nothing. Also, trainers don't have a lot, except for the ones at the top. Trainers also do a lot of things besides training, we clean the gym, go to competitions, do everything.

**Are there things that are not important and could be left behind? Why?**

I think that the app is great for the gymnasts and trainers for the techniques, it can be helpful. But for me as a judge, it is only interesting for the difficulty values and the angles. But I don't want them to use the technology to replace judges. It is very pleasant to be a judge, everyone knows each other, we are a community. This will disappear, which is a shame.

**Do you think this technology will induce more fans watching/following the sport?**

No, I really don't think so, as I said for the parents, they aren't interested in what other gymnasts do. It is because of stars such a Simone and Nina that the sport will get more known, they will attract new fans. But the technology, no. People don't like to watch warm-ups at competitions, this is why the FIG is shortening them, and not doing them on the podium so that they are less long. And I don't think that the technology is a tool that will attract fans.

*3. Marleen van Dooren*

**What is your first reaction after seeing this video and being introduced to the technology?**

That there is a lot more than I expected, I had already heard about it, but I hadn't seen anything yet. I think it is magnificent, if that could limit the errors we make as judges because of our human limitation, then why not. I am sure that judges make a lot of errors, I know this from my own experience, there are things we just cannot see. For example at worlds in Doha I was D1 judge on floor, when the gymnasts perform on the other side of you, she is 15 meters away from us, then you don't have sight of her feet. So it is logical that we cannot see everything, one time it will be in her favor, the other time it won't. With this system, it will always be correct and it will again be in her favor, or not.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

If they use only this system and there is a computer failure, well then they are seen of course. Systems that are not running on a separate network, because there will be a transfer of a big amount of data when the men are competing on all 6 apparatus at the same time, I think that that is a challenge, but I think that the Japanese are good enough to avoid that. The human brain may fail during the day but is always available, while an artificial brain not always is. So this is a weakness for me, after all, it is just a computer. When I see how the images are analyzed and that they can specifically measure the rotation on floor and it should be 360° and then it comes up that it is 356°, we cannot see that as judges, so then it will work as a disadvantage for the gymnast. But on the other hand, when we have a sharp eye and we don't credit something but the computer will credit it, it will work in favor of them.

I know that the FIG started with the IRCOS system, which is a video recording system, 10 to 15 years ago, in the beginning as a D panel we could watch the video in real-time, not in slow motion, which is logic, and it has also raised doubts. And I am very happy that they moved that away from the D panel tables and that we are not able to do that anymore. Because when you know you have that as a back-up, you judge with less vigilance. If they put this new system as assistance to the D panel, then it might have that same problem. Unless they say that they don't need the D panel anymore and just use the computers. I think it is necessary that they use only the technology for the D, and that judges do the E score. For women's gymnastics, only one apparatus is bonded with that artistic aspect and that is floor, the other apparatus are purely technical, so there they could use the technology for everything. But then if you use the capacity of judges to create bigger panels, now we have 5 E judges + referee judges,

earlier we worked with 6 E judges, now if they would go back to 6 or even 8 E judges and then instead of dropping the highest and lowest score, dropping the 2 highest and 2 lowest scores, then I think you still have 4 numbers that count but there will be even less room for manipulations to favor or disfavor a gymnast. But then the correctness of the technical score will always be debatable, there is still some emotion and if they would remove that emotional aspect of judging.. even on a bars routine when you have the style of Nina or that of another gymnast, as a judge you can look through that because you look to how they execute it. You can appreciate something more because it is a more original routine, but if you have some experience on the world level than you will look through it. It is the same for floor routines, you can have routines that catch more the attention of the audience, but judges that have to evaluate 200 routines in qualifications, they block that out, because you cannot hold on. Unless that they would add an artistic judging panel like in Acrobatic or Rhythmic Gymnastics. But then I think that the FIG will have to seriously train the judges on the artistic aspect because we are not used to look at it in that way, you almost need specialists like choreographs who can dig into it more deeply as the FIG wants it. Now, a very ugly routine, which would mean that nothing is on the music that music and gymnast aren't performing as one, would come to a 1,4 deduction for the artistic aspect, that is not that much, well it is a lot for a complete routine, but I don't think that has ever happened. The most that I have penalized for that was 8 tenths, and that was at a world championship. But most countries are working on it, so it is improving. So to keep it in the same area of 1,4-1,5, that won't work. If you put a computer on it, I wouldn't exclude it.

For now, we still need human judges for E, for the artistic aspect. I think if they already make a step for D and that they can show those images and the symbols on the screens, and that the audience gets more involved, then I think that is already a big change for the upcoming four years and a step in the right direction. And then during these 4 years, they test the E score evaluation with the technology. Now they don't have enough material, because they don't have enough cameras in the testing phase. They have to put it on all apparatus and do tests for their own analysis of the E score, and then see within four years what the results of that will be, it would be too fast to already evaluate the E also. The D score is easier, that is purely what is performed, nobody can lie about it.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes. I think if I would go to a competition, not as a judge, I don't do that I only go to competitions when I judge, then it gets boring because there is no atmosphere in the arena. So if there is something that can be offered where you can follow more what is happening and you get some explanation, we know the explanation but someone who knows nothing about it, then I think that you will enlarge your audience. But, and I found it remarkable in the video, the person is sitting in the audience, and is looking on its smartphone screen in his hands. I think that is idiot because then you miss the experience in the arena, I think it is more interesting that the information is shared through screens in the arena. If you have the app, you can watch it the same way as at home, then it is an added value. But to watch on

your smartphone while you are at the competition then you miss everything. It is like recording a routine, then you watch the routine through your phone, and then you see nothing while the athlete is performing live in front of you.

**Why are competitions boring to follow and how could that be improved?**

I think that the audience in gymnastics thinks that they have to be quiet. What we also experience is that it is an individual sport, and it gets even more noticed because nobody cheers for someone else. Everyone is on itself, if you then see YouTube videos of college gymnastics in the US, there everyone knows each other's routines, there it is a team, and within a team, it is like that, they are performing the routines of their teammates from the sidelines. So it is a completely different experience. I think that at a lot of normal competitions, the audience doesn't dare to be loud and that they think that they aren't supposed to cheer loudly. So if we can enhance that, that would be great. With the Gymfed we had a brainstorm on how to make the competitions more attractive. On one side it is through the speaker, that he involves the audience more and also gives some explanations. And if a system like Fujitsu can help with that, it will provide more of that. I think it could also help with some other sports like Judo for example. I think that if you add more information to the broadcastings of sports then people will understand the sports. So I think that it is definitely the right step to appreciate more the sport. It's the same with basketball or volleyball, we don't know why there is a whistle, and if such an information source can explain to you why some things happen then I definitely think that you can get the people more involved with your sport.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, I think so, why not. I think if you raise a campaign. It will also have to come from word of mouth advertising, and if you can say well now it is really nice to follow the sport because of that technology. I think that it can also attract the audience at home. If they effectively use it at the Olympics for gymnastics then it will definitely be brought out by the media, and a very wide public will see it. But the question is how they will make it affordable for federations to use it in the gyms or at bigger and smaller competitions, to also give it to the audience here. And it will possibly have a gigantic price. At the moment it is a FIG packet, so it can only be used for world championships and world cups, for example, the UEG [European Union of Gymnastics] doesn't work with the FIG anymore. They also worked with the Longines points system, but that was so expensive that they have another partner. At this moment Fujitsu has a monopoly so they can ask what they want. But I think it is such a costly packet to use at a European championship or another competition, to let a team of I don't know how much people come over, with all these cameras. It is a patent, in the end, I work in pharmaceutics so I know a lot about it, it is logical that they ask a lot for it economically, otherwise it doesn't generate enough income.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think if you use it on the biggest sports broadcasts that there is, like for example now with the Olympic games I think that will attract fans. In Belgium we get more and more attention so that is already an advantage, not all sports news is about soccer anymore, so that makes a little difference, but it will always stay like that. When we hear the people from VRT, they say that it's difficult to translate to the audience to explain on television, it is a sport for knowers and no one more as knowers, so if you want to make the sport more attractive for the audience, you will have to simplify the rules, but then if you simplify it there will be a discussion about can you then distinguish gymnasts, will a Biles be a Biles with 3 to 4 points ahead of everyone else. If you would go back to the scoring system of 2004 where everyone can start out of a 10 maximum, then you cannot do that with the system that has been used since 2005 and has developed the sport in another way. I think definitely that it is difficult to understand for other people, it is the same that I experience with other sports. People criticize that it is too difficult, that is a critique that is critique, if you are interested in something you will try to understand it, if that information is more accessible to people through the media then you can attract spectators. I don't think that a lot of people will search on websites like the FIG for the information they would like to get because that is absolutely too technical. I think that each sport should have a part on their website that is accessible for the general public, or that there is 1 sports website where each federation explains its rules in a very easy way. On Facebook the Olympic Channel posts videos about all the sports, I think that is great and that is how they can attract fans. So it is all about providing more information and more explanations. And images are also more clear than text. So the technology is a step in the right direction. If people have to install only one app so that they could understand a little more, if they are a little sports-minded, that is good. During the European Games, I went to a track cycling competition and that is very exciting, but you have to understand the rules of why someone does this or that, but it is very exciting, and then I had someone next to me who explained a little bit. And it is so exciting, but how many people will have watched it on TV, I don't think a lot, because it is too difficult, and because you cannot find it somewhere where it is explained in an easy way, besides Wikipedia maybe, but that is in text and not with images.

**What do you think judges will think of the technology?**

I think that for a first instance judges will react in a negative way because they will feel threatened. And I know from within the women's committee in the FIG, they are not eager about it. Or at least, they weren't at the time of worlds in Doha. They were like: "they don't have to think that they can replace us". I haven't been at worlds in 2019 so I don't know what the feeling is now. It is something that has to mature, it will depend on the FIG. if the FIG is smart I think they don't interfere with the E score yet. They should focus on what they said, that they can see the clarity of the technicity of a skill in the D score. And then hopefully everyone will see the advantages of the system, and then they will be more open towards the system. For small gymnastics countries, I think it will be an advantage for them, for big countries it could be a disadvantage. Those countries often assume that because there is the USA logo on the leotards, that they get it. I think that that was the case. But at last worlds on beam I think that they showed that it isn't like that anymore. There the US was proved wrong and they feel now that something is changing. It was known that Russia, China, the US, or Romania earlier if they were competing, no one dared to take a lot of deductions, and that is gone now. But gymnasts from small countries can get

disadvantaged because judges would be like “she won’t be great”, and with the technology, you can neutralize that on the D score. It is going away, the splitting up of D and E score has made a big difference in the judging.

*4. Sander Raeymaekers*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think it is interesting, it is a way to modernize gymnastics. Gymnastics is one of the most viewed sports at the Olympics. Finals at World Championships are sold out and there is a lot of demand. But for qualifications that is a lot less. You cannot compare it to soccer or tennis, the competition formula is different. This system could help to bring it closer to the public. But I especially think that gymnastics is too difficult to understand, it is built very logically, for me as a judge I like it and I look at it with a lot of admiration. And a normal person will look at it and say “Wow, cool”, but to go watch that every weekend, that doesn’t interest them. Once in four years or every other year, my friends ask me when is the next competition that they can watch on a live stream. They like to see it occasionally, and in that occasionally is that they find it cool to see it but they won’t watch it every week. Because it is not very clear who is winning and who is not. I have been at competitions where I thought some things were not fair, therefore the system could help, but the audience doesn’t know if that is fair or not.

There have been some challenges, maybe they should make the apparatus easier, or have less apparatus but concepts such as [Gymnastics challenges], that is a competition format that is attractive for spectators, there it is all about one skill. At a normal competition it is about 10 or 8 skills, and the connections and such, and that is difficult. If they only have to do 1 or 2 skills then it’s nicer for the audience, then it is clear who wins or not, or with an arbitrary who says who is winning. And then you have that Fujitsu system that can immediately say that it was better executed and then the audience knows within a few seconds who wins even though they don’t really know the rules. But what I am afraid of is that the system may have another way of thinking than judges always had. I don’t have enough details about it. If we consider something as straight, in the video for example there was someone who performed a cross on rings, we as judges would consider it too low, but the system would consider it as perfectly straight. So the federation will have to be clear on what they want.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

I like the system, it will bring some more clarity about what is straight or not, we are just humans, we make errors. It is like in soccer, the referee is always right and in gymnastics it is the same, the judges are always right unless you want to pay €300/€400 for an inquiry. A lot of trainers just acknowledge the judges’ decision. I have to say that as a judge, I am not always sure if I am right. When I am with 2 or 3 other judges, then 1 out of 15, or 1 out of 20, I am wrong. If I would be alone, I wouldn’t be corrected, and such a system can do that.

The disadvantage is that it will have a very high price and that in the beginning it will probably only be used at the Olympic games, maybe at world championships. So you cannot use it at small local competitions, such as provincial qualifying rounds in Flanders. In Flanders we are maybe privileged because of the strong bonds with the FIG, we maybe could be used as a test audience but I don't think that the Gymfed has one or two million to spend on this.

Another disadvantage is, suppose that you can implement it all over the world, then a big part of the knowledge of the judges will go away. We are trained on a yearly basis, every four years we are tested to achieve our international level. In Belgium too, every four years we have to achieve our license. That is just studying a bit and practice and you got it again. I think that is positive, otherwise, you would lose the feeling of it. But these judges also come in gyms, to point out what is wrong and right and to give advice on routine composition. I suppose that that system also can do that and if you say that you have a gymnast with these limitations and these strengths, that it could build a routine for that gymnast. But then you will have to pay for it, well I think. So a big part of knowledge will get lost if the judges are removed. I don't think I would like that all the judges get replaced by machines. The trainers can also read the CoP and compose routines but, it is always the case that when a judge enters a gym, even for the national team, they see more things than the trainers, trainers don't think about everything. Sometimes because you focus on some skills or some parts of the routine, that you lose sight of the entire routine, and that there are some things that could be better. I know that the system of Sports Innovation in the Sportslab in The Netherlands, I have seen it a few times at European Championships. It is a pressure sensor for on rings, it exists for five to six years. I like that technology, you can analyze it. Of course in a hundred ways it isn't as comprehensive as the Fujitsu technology. But it is something that could work, and it has already helped, the UEG is thinking about using it at competitions. So I have seen that such a system can work, as a helping tool for the judges. But to make such a big application for the audience, I think it is too far-reaching for only that implementation.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes. In certain ways it will be an improvement, it depends on how you apply it. For the fans, if you can see afterward what the positions were and where the deduction comes from, to clarify that is good. But on the other side, I don't know to which extend the system will apply the letters of the CoP. In the spirit of gymnastics when a small error is made, with the human eye, but then they put the degrees on it, 30, 45 degrees, that is not fair, actually they should almost remove it from the code because we as humans cannot see if it is 14 or 16 degrees, that is not possible. In the spirit of gymnastics, we interpret that and say, it is not perfect. So maybe someone who does it at 14 degrees and we say it is a deduction, and then there is another gymnast who is very clean and is at 16 degrees and we consider it as good. So there the system could help, is it fair? Yes. Or no. Maybe we will raise robots of gymnasts, who try to be perfect without the feeling of the movement. Yes, they can help with training the different angles and positions, yes that is helpful and nice. On the other side, the spirit of gymnastics, the feeling of a skill to

make it look natural, will go away. To perfect movements, it can certainly help, but to learn new skills that is something else. To reach 30 degrees you have to pull for that much Newton on the bar. Yes, that system can calculate that, but a coach has to translate that to something practical so that the gymnast can work with it. It is like saying to a gymnast, 'you have to jump higher', the system will also say that "you jump at 1m20, that is too low", the system won't say how you have to jump higher, maybe in the future, it will. As a trainer, you need to do a practical translation. I think that the skills of trainers will fade away. So I don't find it a big added value for trainings, for some movements yes, for others no. Yes for at a high level to polish skills. Eventually, the system was originally made to evaluate gymnastics movements, so if it can help us for that, or for the analysis of errors in the learning phase of some skills that would be useful. But I don't think it is a big added value in the learning procedures.

For spectators. I compare it to Hawk-Eye in tennis, it is very nice, but it is only applied by the 'challenge', when they think it was in, based on the feeling of the tennis player. And then there is an immediate replay to see if it was in or out, that is very nice. It is like the goal-line technology in soccer, it works immediately, is it in or out. For gymnastics, it will help to make quick decisions, but maybe it will break the system. There was a similar system in 2010, IRCOS, which videotaped the routines. The judges were judging, ultimately they always replayed the whole routine to verify. And they stopped this because they didn't judge in real-time anymore which is the purpose of judging. And with the slow-motion footage, it wasn't completely fair to do it more for one gymnast than for another. But it could be a system that analyzes the whole routine in the background, and if a gymnast calls a score into question, that he can ask to get a correct evaluation of its routine by the technology. It could be a solution that it evaluates the D, and then judges do the E. but on the other side I don't think that the problem is in the D, it is more in the E. If there are cheaters within the judges, which is another aspect, giving advantages of disadvantages to gymnasts, that happens more in the E score than in the D score. On an international level, D score is great you determine the difficulty, but that is quite fixed, you can complain about it, and these inquiries can be accepted or not, that is not that bad. But the E score for a judge is more important because there you can 'cheat'.

[Does that 'cheating' happens a lot?] Constantly. Consciously as well as unconsciously. For example, you have a gymnast of Charleroi and one of Ciney, what will you do as an evaluator? You will think, "those from Charleroi, which is a good club with a high level, it will certainly be a great gymnast". Even if you don't think that consciously, unconsciously you think about it, they have the same leotards and that stuff. And someone from Ciney or another club, they can maybe perform better and more beautiful, but because they are from another club, and have a leotard that is not that beautiful and nice, and doesn't have that many sparkles, or because they come from a club with a bad name, you maybe can evaluate them differently, it is not always consciously. It could be that this bad club has a new trainer for 2 years and that the gymnasts have better performances but that it isn't reflected in points. It is what they did with Nina Derwael, they let her compete at international competitions, just to show her style and movements, in fact, to let the judges adapt to Derwael's style. It is incredibly important that the judges know you, that they are like "Oh Belgium they are great on bars", Belgium is also known for its artistic value on floor, we score greatly on that. Nellie Kim has often said that Belgium is a top country, that it is

an example of what the FIG expects for artistry. On the other side, the Russians are known for their technical perfection and their ballet. And then the Americans are known to do everything very powerful. And there can be an atypical gymnast who doesn't have that.. these are all prejudices that are in your head. And the bargaining in that is not small, the judges are together in the hotel in the evening and they go drink something. And they don't even have to talk about it, about how they will evaluate each other's gymnasts. For example, if you like the judge of Lithuania for example, and the next day when a Lithuanian gymnast presents, you remember that it was a nice evening with that Lithuanian judge, and that could influence your judging unconsciously. So is there some cheating, yes and no. For example in 2010 or 2011 in Ghent, all judges knew that a certain gymnast should get 13.5 if he doesn't fall. He falls, so everyone judged normally, but these deals are made. I know that there was a Belgian judge who was at the World Championships in Antwerp that was banned because he made some nonarbitrary evaluations. They have dealt with it in silence, nobody was really aware of it. Bans happen, and your scores as a judge are registered and compared with a statistical program, and on the basis of these scores, they invite you to come judge or not as an apparatus specialist. So to bring more objectivity in the gymnastics world, that system is good. On the other hand, there is a lot of human input needed to evaluate in the spirit of the CoP or in the gym itself to bring over the rules.

For the artistic value for women's gymnastics I think they will have to adapt the code to be more clear: the leotard matches with the music, the routine matches with the music, the leotard matches the routine. Another factor is that the system doesn't get tired, a judge does. Judges are expected to evaluate in the same way, from the first to the last gymnast in the competition, at qualifications at worlds that lasts two days with six sessions each, that is executioner work. Most of the judges are 50, 60 or 70 years old, these are older people, I don't want to undermine them because these are great judges, and most of them are judges for more than 30 years, for them, it has become second nature. So they really want to do this in good conscience, but there is still the human factor such as fatigue that they don't really have under control. Take for example that Nina Derwael competes in the first subdivision at the Olympics and gets evaluated a little bit too harshly compared to the gymnasts that compete in later subdivisions. So for these things the technology can certainly be an amelioration.

Maybe that a hybrid version is the best system, that the system lit up a light when an evaluation has been done too strictly. That is what they wanted to do at the time with the reference judge, it was supposed to bring clarity when there was some discussion, but it was more complicated than they thought it would be. And they will remove that in the new CoP after 2020, for the men in any case.

I don't think that people watching gymnastics have an unfair feeling, they know so little about the scoring that they are not asking themselves if a score is fair or not. Maybe that the 10% knowers in the arena will remark something is wrong with the judging. Maybe in some extreme cases such as in Athene 2004 with Paul Hamm, there the judges were right, but the audience just has a completely wrong impression. And there is the discrepancy, the audience wants to see a spectacle, cool things, if someone does two flares on floor, then the whole audience is like "Wow", while it is only an A skill. While if someone does a quadruple twist or a triple-double, they will be less impressed, the audience doesn't see the difference

between one or two or three twists. But it doesn't have the wow factor of flares, this is why they try to add some on pommel horse to add some spectacle and entertain the audience. I think that they should, it doesn't have to become a spectacle sport, but they should listen more to the audience and do some fun things.

And it has also to do with the atmosphere at competitions. The Top 12 in France, Bundesliga in Germany, and the NCAA in the US, that is fantastic to go to. I have never been to one but when I hear the stories of others, that is wow. And then you have the Gymfed with the small competitions who wants to entertain the audience with a speaker, yes that is one thing but I think that something more needs to happen than only that. And yes people that think about that compare it to other sports and try to copy the 90 minutes of soccer, that is approximately the time that an audience can watch something with fascination. In soccer it is a clear goal or not, one more than the opponent, that is clear. In gymnastics, if someone does a summersault and does it with a half or full twist that is worth 1 tenth extra but that doesn't say a lot. The Bundesliga is with direct duels and with points and that is much more understandable for the audience to follow. With our system now you have to wait until everyone has competed because one gymnast gets his chance a little bit later on another apparatus and will be a little more tired. So another format of competition would certainly help, I think they have to work on that. I fear that for men's gymnastics on the international level, there is a lot of competition between the countries 20 until 30. While that isn't the case for the women.

But when I look down the ladder of gymnastics, we get the little boys at six/seven years old, their level has incredibly lowered than 10/15 years ago. And then I ask myself if we have to achieve the same norms when they are 11 years old, it gets more and more difficult. It is due to less freedom of movement, computers, television, tablets. I don't know, they used to play more and they had already done these natural movements. Now we have to learn them to do a roll and walk, to say it like that before we can teach them gymnastics. And then I think that gymnastics is maybe too complex, then it should go a little more to parkour whom the Gymfed and the FIG went in business with and are trying competition formats. I think that that type of competitions is appealing, it is cool and fun, it is down to earth, understandable. They have some speed competitions where they have to perform as fast as possible, that could help, but I know too little about it. So gymnastics is nice to watch every four years, but to watch it every week, I don't know that that is possible. Because it is too complex.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

There is much more needed than only the technology to help that. If you look at the provincial prelims, there is not much audience. The clubs don't want to organize it because they don't earn much, only at some competitions. The first competitions, the I-level attract a lot of people because it is the first competition of a gymnast and they want to see their little kid perform. But they don't go to the competition because it is spectacular. At the most spectacular categories, A and B level, juniors and seniors, it is very nice but there is nobody in the audience. People don't come to watch, maybe it is known that there is a competition, so I think that more promotions of competitions could help. It is like a Belgian

Championships, there is not a lot of audience, there will be some people that will come out of interest, but too little.

And one big factor in this is the media, which plays an incredibly important role. If it doesn't have to do with world championships, the Olympic games, or Nina Derwael, then they aren't there. I think that Sporza only comes to watch how the women's team is doing, but for the rest, they do nothing else of coverage, because it doesn't provide them viewers at a lower level. Of course, you talk about a lower level, at soccer, there also not that many people come to watch low-level matches, although sometimes there can be a lot of spectators too. I find gymnastics really fun and intriguing, and I like thinking about it. There are a lot of challenges as a trainer, as a judge, but if it will keep having success under this format, I have no idea.

On the other side, if you look at the statistics of the Gymfed, they grow each year, the number of members and participants at competitions is increasing, so there is a market for it. On the other hand when I look at the competitions, how long they last and how much gymnasts there are in the categories, and how boring they are, then you have to go to other competitions where you have two or three platforms and a room where they can warm up so that they can compete within one hour. Because if you have one hour of warmup between each competition, the audience is sitting and waiting. Everything also happens next to each other, Lode Grossen is right about that and I have had that idea also, it could be that a world champion, an Olympic champion, and another top gymnast are all performing at the same time on different apparatus, in a qualification, or an all-around or team final, as spectators you don't know what to watch. In another sport that would never happen.

The technology will make the competitions shorter which is good. But it will be one gymnast after the other, it will maybe become a show-off and it will be too much rush, rush, rush. While now the slow competition gives some rest between the routines. But I think that competitions of one hour, one hour and a half, that is how it should be, and the trainers will have to train their gymnasts for that. The 30 seconds warmup that a gymnast gets before each event is needed for them, but on the other hand that is redundant waiting for the audience, they don't like to wait, they want to watch everything immediately. Such gymnastics competitions are also chaotic, all the apparatus are set up in another direction, and sometimes you are far away from some apparatus as a spectator. So it could help that if the judges aren't there anymore that you can let the public come closer, or enhance the visibility. This week I was thinking, imagine if they have one ball with 20 different cameras that look in every direction, then you could analyze everything from that ball because now they will have to set up three to four cameras, if not more, very precisely and they will have to calibrate it and such, that is not simple. I think that they may also adapt the apparatus on that, in order that they can calibrate it more easily. On the other hand, I know very little about it, I haven't been looking for it actively, on the other side if big steps will be made I think I will hear of it. I only know what is reported in the media, but not internal what the federation is planning to do.

The Gymfed is an innovative federation on that purpose, so I like that. It will be a big improvement, I think that the biggest improvement has already been done and that is the scoring system. Score Express

with which you don't have to manually enter and calculate the score, and that know immediately after the competition without inquiries and big errors, you have the results. Now with the tablets, we as judges have quite some control about the scores, which is a big added value to accelerate the competition at the end with the podium ceremony. And it also eliminates the factor of human error in calculating the scores.
I think that marketing-wise, big steps can be made and that there are already some people busy with it.

*5. Eleni Lari Carillo*

**What is your first reaction after seeing this video and being introduced to the technology?**

I hadn't heard about it before. I think it is interesting, I think there are good sides and less good sides about it. For the accuracy of the results, it can be very great. But I have questions about the difference in body types and the different body positions of everyone. The first impression I have when seeing it is that there are girls who are sometimes in a handstand position but who are not very straight, like they may have a hollow back but are still in a handstand from a judging point of view, I wonder if the technology would consider that or not and if that will disadvantage some gymnasts.
A disadvantage is that it will take away the human aspect to judging it will be completely robotized.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The advantage is that it will be way more correct. As judges, clearly, we try to be as correct as possible but I know that sometimes we make mistakes. It is possible for trainers to fill an inquiry, but they don't always see if an error was made. With the technology it will be correct, so for the gymnasts, it's great. And for the cheating and so, it happens rarely, but at least with this, there is no possibility.

On the negative, these are robots, they will take the place of the judges. I like what I do, when I judge I like that, so it would be sad if they take that human side. And consequently, there will only be the athletes at the competitions. It takes jobs away.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For what I have seen for the television, that could be great. It could be very nice for the people, it will help them to understand a little better, so to have something else than only the points, the height and such, so that they can more easily compare gymnasts. I think it will make it more entertaining for the people to watch, and I think that that could bring another audience. People like to watch gymnastics but they don't understand anything about it, they just watch for the beauty of the sport, but it is difficult to understand, so that could be positive. Another positive thing is that it would also help to shorten the competitions when it is on television for example. The judges will only have to do the E-score, but in general, that doesn't take that much time, so the gymnasts would perform one after the other, there won't be that much waiting time anymore, so that is clearly a good thing. That is also a thing that is

annoying for people who come to watch, or who watch on television. If they can immediately have the D-score because that is what generally takes much time, so that would be great.

For the trainers, they will like it because it will remove the subjective side of the judging. And for the gymnasts, they will be evaluated more correctly as there won't be room for errors anymore.

For the judges, it is a big disadvantage if they use it to replace them. If it is used as a tool to help than it is a positive thing. For example, if the machine can do the D score, and there would be more judges for the E score, then that could be interesting. Because there will always be human judges needed for the artistic part, I imagine that the machine cannot evaluate that, maybe in the long term yes. If they use it only for the D score that would be very positive, because as a judge we see something from certain angles, it is not always in function of how the gymnast moves. For example, if she performs a thing in one way or another, we see it better or not. So obviously for the D score, we give our impression but we are not always sure, we try to do our best. It will be very positive for the gymnasts that they are evaluated correctly. But I have questions as to how they will evaluate and credit skills. Every gymnast has another body type and different techniques. In general, when we judge we don't look at the whole body, we look at one or two important points to look at in every skill, such as the hips and shoulders, or in leaps, for the split, we look at both heels, but we don't take the whole leg or body. So I am quite skeptical about the E-score, I think that anything is possible but, just the differences in body types and techniques and such… for example a split position, there are different ways to be in a split position, you can have the legs in front or more to the side. So that seems complicated to me, but we'll see. I am more convinced for the D score. But especially in handstands, everyone has different ways to position itself in a handstand, and sometimes you can be in a handstand, without being correctly in a handstand but it would still be credited, you can have your shoulders and feet well positioned, but the rest of the body isn't because of a hollowed back, in that case, will the technology credit the handstand or not. So they will have to take that into account.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, of course. If they can give more information on television I think so. In the video I saw that they show the live performance in 3D on the smartphone, I don't understand the goal of that. It has no interest to watch a live performance in 3D on your smartphone while you are in the arena watching live performances. Maybe for people who watch from home on their screen and want to see it in 3D but I don't see a lot of interest for live performances, maybe to watch afterward yes. What I think is really interesting is the additional information it can give in real-time, such as the value of the skills that are added up, to understand the final score. For example, if we see the value of the skills of Simone Biles, I think people will realize how much more difficulty she has than the other competitors. So that is obviously very positive. Even the height and such, for example on vault we have difficulties making a difference between a good vault and a very good vault. If we know the exact height and length of the vault we can take that into account, and that is very helpful as we can take deductions for height and distance. It is very approximate for us, often it depends on the first vault you have seen. Or sometimes you see a great vault and take almost no deductions, but then you see an even better vault, even higher

and further, and consequently, you also take almost no deductions, but there is no difference between the two. I think it can really be helpful for that apparatus, but that is the E score then. I think it would be good to not only show these metrics to the audience but to also use them in the execution score. It could be used for everything where deductions for height and distance can be taken, for us as judges that is always a rough estimation, “what is the height?”, they don’t say 1 or 2 meters, there is no reference. So in the long term that could give references. It could be interesting for the E judges, for tumbling passes or leaps, to have that information on their tablets, what hight a gymnast got on a tumbling pass or a jump, and that they make averages or I don’t know. But then if a gymnast is taller or smaller, that is not evident, they will have to take that into account. These are ideas that could be helpful, but it is not that easy. But especially on vault it could really help to put values on height and distance, either way for me as judge and I think everyone agrees, on vault it is difficult to differentiate the good vaults from the great ones, and I know that people complain about it. A good vault generally doesn’t get deductions for height and distance.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

I think that since a couple of years they do something great, I think it is since World Championships in Glasgow 2015 they started to make a little bit more a show of it. Like the presentation of the gymnasts and such, before that has never been done, there was never a show around it. And now more and more they make a show around it, I think that that is something that attracts televiewers, and even people to come to watch. It is much more interesting, it is much more fun, they name the teams, there is much more visualization with pictures of the team, they make clips in 3D, it is much better. So they certainly have to continue with that, continue to make it more like a show, which hasn’t been in gymnastics and was more in other sports. And also explain or better explain the rules, for example, they never do it, but before the competition starts on television they could explain the rules in a simplified way. Nobody ever explains that the score consists of two different scores that are combined and such. So it can be interesting to do a little recap for people who watch it on television before the competition starts. I think that if people understand it, they will be more interested, and if they don’t understand it is more annoying. But then it is always the same, make it more artistic, they try to go there with the CoP, but consequently, the problem is that it is more subjective, while they don’t want to be subjective, so it is a whole discussion. But clearly, the people who don’t know gymnastics, everything that is more artistic or beautiful to watch, that is what they look for.

I think for the competitions of a low level, you cannot do much about it, there is not a lot of audience because it is only the family that is interested in it. There are not many impressive things happening, even for the family sometimes it can be annoying because it is long, because it is not very impressive. So for a low level, I think it is difficult to attract more audience, but that is like in any other sport, the higher the level, the more audience. But for Belgium to have more audience at high-level competitions, which is interesting for even people who don’t know anything about it, it is the same thing, to add some

show, visual effects, create a whole thing about it. And also, it is developing on Instagram but, to make more publicity, and try to reach more people.

## 2.4 Fans

### *1. Hannah Mouillot (written)*

**What is your first reaction after seeing this video and being introduced to the technology?**

At first sight, I am rather against it, but after some reflection, I think that it is worth trying it.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

On one side, it is good to counter the subjectivity in judging gymnastics. But I think that we have to conserve some part of that subjectivity. Otherwise, we risk to fall into the robotization of the discipline. Judging with robots that can only measure some mathematical parameters, such as straight lines and body angles, while gymnastics is also judged from an artistic side, such as the expression on the floor and body tonicity.

I also think that the app that will be used to judge, will be configurated compared to an ideal. Yet, nowadays we don't find a gymnast that performs a skill perfectly, as the execution scores are always inferior to 10.

Concerning the fans, I think that it could be a real plus. As a matter of fact, for people not practicing gymnastics, a competition is difficult to follow. First of all, the scoring system is complicated, also the deductions are quite difficult to understand for non-practicing. The technology would allow a big audience to understand gymnastics competitions. Inevitably, it would make gymnastics more attractive, and more people would watch gymnastics competitions. And maybe also watch more gymnastics on television.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts and trainers, I think that will require to rethink the training methods. The trainings would be more about performing a skill until perfection. So I think that a gymnast may not appropriate themselves a different technique.

For the judges, it would be useful from a technical point of view, the judges could trust that virtual intelligence. Only the artistic aspect and the body shape (the tonicity) will have to be judged by human judges. So fewer judges will be at competitions, which will be easier to organize.

For the fans, I think it would be very interesting for them.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, I think it would play a role to attract fans, and it could also serve federations that could see an increase of followers.

**Are there other things that might be (more) important to help the sport move forward?**

I think that before all, it is a question of mediatization and understanding the rules. Yes, soccer and tennis are sports where the rules are known by everyone. People who don't practice these sports can tell who is the best player, who scores more or who loses the ball the most. This isn't the case for gymnastics.

**Are there things that are not important and could be left behind? Why?**

I think that everything that is mentioned in the video is important. It allows to set up a framework, it appeals to people who already know a lot about gymnastics, the invested fans, as to fans that don't know a lot about gymnastics

*2. Marine Dutoit*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think it is a good thing, but what they say about the spectators, I think they don't care about seeing angles and heights. But I think it is good for gymnasts to see how high they go, or if their legs are straight for example, it is easier than having to take videos by themselves. For the judges I am not really for it, to calculate the D score yes, but not for calculating the execution score, I think that the judges need to do that. Or when they really have a big doubt then they can re-watch the video. But with this technology, there won't be any judges at all? I don't want it to take the place of the judges.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The advantage would be that there would be more precision and less cheating from the judges. Like it is their own gymnast so they evaluate less strictly, for that it is good. The judge doesn't necessarily see everything, sometimes they lower their head to note something, and then they can miss some things. It would be more precise and more objective. There will be less cheating, everyone will be evaluated the same. But for me it is important to keep the real judges, I am not such a technology fan in itself so this is the biggest disadvantage. I don't like robots and such. But for gymnasts, it is super interesting.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, I think some people will be curious. When you watch gymnastics on television people don't understand a lot. With that application, maybe they will better understand what is happening and how the technique works and such. It will attract curious people, but I don't think it will attract new people.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Definitely the gymnasts and trainers, they can visualize and correct their errors. For trainers, it is easier to explain a new skill with something visual than orally. But for the big audience.. yes if they are really curious, otherwise I don't think so.

**Are there things that are not important and could be left behind? Why?**

For me, the technology can calculate the difficulty score, but nothing more.

**Are there other things that might be (more) important to help the sport move forward?**

They should show it a lot more on television. Soccer is broadcasted every day while gymnastics only ones a year. If they would show it more, maybe more people would get interested. Also making the sport less complicated, when you comparing to soccer that is very easy. Maybe by showing how the score is made up people will have the desire to try to understand. I think that is the problem, it is too complicated and that is why people are not attracted to follow it. I got introduced to gymnastics because I knew someone who did it, it is not a popular sport, not many kids start doing gymnastics. And also the fact that we have Nina now, the fact that she has international success, a lot of Belgians now know here even though they don't necessarily know gymnastics. So I think that if the Belgians achieve results it will make the sport more known.

*3. Frédéric Debourse*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is interesting for the analysis of movement. And I think it will be great for the judging, that it can be neutral because let's be honest, judges evaluate, they are humans, they aren't always impartial. We agree, when you have a big name, when Simone Biles is there, then immediately they know she will outperform the other competitors. It is beginning for Nina Derwael too because she is known in the gymnastics world now. It is sure that it is not always objective. But this technology will have to be updated a lot of times.

The first thing that comes to my mind, it that the danger of this is to standardize, and that there won't be novelties. When a new element is performed, the software doesn't know it, and can't take it into account, so at a certain point, there won't be innovations in the sport. The sport will not develop anymore, yes they will make little robots out of the gymnasts, they can perform the skills perfectly, but the innovation, the little thing, the grace will go away. Personally, I don't like seeing Simone Biles' gymnastics, she is a little human with a ton of muscles, technically she is perfect, but if you compare her to Nina Derwael, it is gracious, it is bigger, more beautiful. And there is that subjective aspect. I think the technology should be a helping tool, it bothers me that one day the judges could be replaced. The gracious, artistic aspect

should be kept, even though it is subjective. The technology is great for technical evaluation, but the esthetical aspect should be evaluated by judges. And there should also be the possibility that gymnasts can innovate and perform new skills. Gymnasts should get some tenths because of the innovativeness. I also think that for the trainers it is a great tool, we have to live within our time, we have to accept the development of technology, but it can't override the human aspects. But it is great, it will also help the shortage of judges. For me, the problem in gymnastics is that it becomes too complicated. Judging courses are difficult, and if they are too picky about the errors, they don't see the whole image.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

A positive is that thanks to the technologically, we will understand a lot more. For a physiotherapist as me, we will understand why some injuries happen because of the analysis of movement. We can compare the best dynamic and physiological movement, to the movement that the gymnast performs. Maybe we can also see the difference in movement between a small and a tall gymnast because maybe they have to do other movements. So we can analyze that and adapt it to the gymnasts to prevent injuries. And the gymnasts will be able to see, I think visualization is very important for the understanding. I see a bigger advantage for the gymnasts and trainers than for the judges. For the judges, it will be more objective, and it will help them. But on the negative side, it will standardize gymnastics, where they won't dare to be innovative. Everyone will copy each other, it will lose the human aspect. But from a physiotherapist view, it is great. We will be able to see why a gymnast gets injuries, why they have back pain. It is already great that we work with video, it is very helpful so that you can analyze very precisely and make corrections. It is really great for injury prevention. Another negative point is that the countries/clubs with the most money will get even better, because they have the resources, while the ones that cannot afford it will be disadvantaged. If they can democratize the price of the technology it can really help the trainers because I think there is a shortage of formation of the trainers.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

Yes, and I also think of the media. The more you understand... gymnastics is such a precise sport that people don't always understand what is happening. As a gymnast, you have a trained eye to see what is good and whatnot. The eyes of the general public don't see that, they think it is beautiful, but they don't understand why a certain gymnast lost two tenths or something else. So it will make the sport more accessible to the big public. With reference points such as the height and timing is great, but it cannot be too distracting. You have to understand immediately when the skill is happening, to know why. I think that to make gymnastics understandable it will be great, and it will make the sport more accessible to the media. The more it interests the media, the more it will interest the public and the more revenues for gymnastics.

I think for me the order of interest will be trainers and gymnasts, judges, and consequently the media and the fans. It can only ameliorate, it is like a chain. The more beautiful it is, the more interesting, keeping that side of improvisation. I think that the judges have to keep those preferences, otherwise, it will be too codified. If the technology takes the place of the judges, it will lose its magic. Every technology should be an aid. If we do not do that, we won't evolve anymore, we will be dependent on the technology. And it is the technology that should be dependent on the humans.

**Do you think this technology will induce more fans watching/following the sport?**

If they will understand it better, yes. It is like for me, I wasn't interested in basketball, my son started playing it so I got interested and started to understand the tactics and movements. So the more you understand, the more pleasant it is to watch because you understand the subtleties of gymnastics. And it gets more interesting to watch, if you don't understand it generally people won't get involved because they don't want to put a lot of effort into understanding it. There will always be some curious persons. And I think even for gymnasts and trainers it can be helpful to have a better understanding of what they are doing. We live in the 21st century, we have to take advantage of these technologies that will be more and more efficient.

I don't think that the technology will attract more fans in the media. And it will also not to have to be too complicated, I am not persuaded that people are getting more and more intelligent. If you have too much information, you will lose, it just has to be there to explain, or to show in slow motion why a gymnast got deductions. It is like in soccer, the VAR should be a helping tool, at the moment the VAR is looking for balance. For me at the moment the VAR is too invasive, it should be like in other sports that you ask for the help of the VAR, now they protest for anything, and it makes soccer lose its magic. Also, gymnastics needs to keep its magic, that moment of awe is important. Too much information will kill the information. Maybe if there is an error they can signal it, not even with a deduction, but with a signal, and afterward in the slow-motion repetition, there they can show the error.

I don't think they should do comparisons, for example, compare someone to Simone Biles. It is not because Simone Biles rotates at a certain time, that another gymnast should do it like that too. It is not a good thing to compare gymnasts to each other, they don't have the same morphology, and muscular tonicity. Physiologically I don't think the technology can do that, to take into account the different morphologies of gymnasts. They will standardize the body type of a gymnast. Physically, smaller gymnasts are better at gymnastics than taller ones. A taller gymnast has longer arms and legs, which makes it more difficult to rotate. They already standardize more and more because they recruit especially small children, other taller gymnasts, it is not that they are bad, but they will have more difficulties and it will take more time. I think that the danger of this technology is that we will see all gymnasts with the same body type, height, musculature. The progression of each gymnast is different, you will have some that progress a lot when they're younger and then stagnate, and you have others that progress at a later age. So you have to be careful. It will disserve the sport if you don't have a variety of gymnasts. You can't compare a Simone Biles to a Nina Derwael. In the long term, they will target and

analyze too much at a very young age, you cannot target only small muscular gymnasts to recruit. And then there is also the mental aspect of gymnasts.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

The most important thing is that it needs to be more understandable for the audience. Also, the media plays a big role. Sports are related to media and money. If there is money, there is more development and it gets more attention. In Belgium it is developing because of Nina Derwael, for years we didn't really talk about gymnastics in the media. Because someone brings medals, the media get interested, because of that there is more money to develop further. If they can develop that technology to aid the gymnasts, we can have more elite gymnasts, with fewer resources, compared to China for example where they have a lot of resources where they can train 1000 gymnasts to finally get 1 star, in Belgium, we don't have that. So we could have more and better gymnasts who could bring more medals, these will get the media interested and there will be more medals, we have never talked that much about gymnastics since Nina won all her medals. The technology will attract more people because it will help them understand better.

But I think that the most important thing is that the technology is used to train gymnasts and trainers, and also the judges, and then the media will follow. It is a chain, you cannot take things individually. If you improve 1 thing, you will improve the rest of the chain. So it will eventually attract spectators and fans. Also, the injury prevention analysis will lead to gymnasts who do the sport for a longer time. I also think that the analysis of movement could help the development of the equipment. And if the equipment improves, there will be fewer injuries. When you look at the floors from before and the ones now there is a big difference. And it makes it also more accessible to perform more things more beautifully earlier. And that could help with the attractiveness of the sport, people want to see beautiful. And it can also motivate gymnasts more, earlier you needed two to three years' time to teach a double back, and now they would be able to perform more things more beautiful, that will motivate them, and the parents. The sport will evolve more quickly. And maybe more techniques could be developed, and even more sports. I think that gymnastics will evolve to be even more acrobatic.

**What do you think judges will think of the technology?**

Gymnastics is a very codified sport, they don't really like changes. We have to evolve, judges will be scared, novelties do scare people, but after a while, they will realize that it is great and it can help them.

*4. Thierry Deleuze*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think it is an incredibly beautiful system, the quality we can get, qua millimeters, distance, power, height, it is a super innovation. But I think it is not realistic, practically to put it in a gym you need a distance of 2 meters from the apparatus, so that seems a problem to me. They will have to work on that to be able to put the technology in gyms. And it will also be very expensive, a federation such as Gymfed and even

UEG and FIG can't buy it. I think that it has a future, not to take the place of a judge, but as a very helpful tool for trainers, I see it more applied in a coaching context, than in a judging context. Because if you train every day with such a technology, you can determine the moment when you have to turn on bars for example, so that is a big advantage. But the subjectivity of the coach and the gymnast is much more nuanced than the system, the system is black and white, it is in or out. It needs a lot of advice from the experts to determine what is within the norm, and what is not, and that will be a long route. The technology will absolutely too strict.

**Do you think this technology will induce more fans watching/following the sport?**

It will be great, I am a fan of this technology, I think competitions are so boring, but really, it is way too long, way too complex. I am at the basis of a lot of regulations, for a lot of years, also at the FIG. for example, the first time a saw the video of the route to Tokyo [the qualification route], I thought that was a nice video, but after two and a half minutes I called the FIG and told them they were crazy. Even I didn't understand the qualification system, and if I don't, I don't know if a lot of people will understand the whole procedure. That is also the problem of a competition, it is so beautiful, it is one of the three most-watched sports at the Olympics, but we understand nothing about it, and I talk only about artistic gymnastics now, even not about rhythmic, that is even worse. So there is something to do. The technology can give a lot of information, I think that a part of the technology, Swiss timing, like Longines and Omega, the scoring systems, try to gather more information. I think in 2004 in Athens, for the first time they gave the speed of a gymnast, but the differences are so small and minimal that it is not relevant for the audience. So for the audience and the fans, we give the right position and the right angles, but as a fan, I would look at like a Nintendo Game, on which we can play guitar and we begin from the start, with the melody, and the closer you are to producing that melody, the more points you get. For gymnastics it is the same, you begin from zero, and each time a skill is credited it adds up to build a score, and that is readable for the audience. If the Fujitsu technology could give that, that would be a very big added value for the future.

**Do you think that will make it more interesting for the audience to watch, to see how the score is built?**

Absolutely, if you look eight years ago, in Formula 1, the only information you got was where they were on the circuit through dots, there is no interaction. If you watch now, you know how much liters of fuel were used, you hear the pilot talk with the team.. this information is nice to know. More and more we watch television with a second screen, you look first on the first screen, and to get more information you go on the second screen, and this could be done with this technology. I am a fan of getting extra information on a second screen, or that the extra information is showed on the broadcast on television, on the side of the screen. That is a possibility.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

The disadvantage of the sport is that there are not a lot of competitions. But if there was an online broadcast with television cameras, where the public can zoom in and watch, and on the side, you get more information, that will be an added value. A web broadcasting with that type of information can be a way to attract more people to the gymnastics world.

Also, other regulations, to make it more exciting, I think that is very important. What does an audience want? They want flight elements on high bar and the uneven bars, they want exciting things. They also look for perfect landings, now what we are doing, gymnasts don't get deductions for a perfect landing, that is unreadable for the audience. If you would do a perfect landing and get 3 tenths bonus and it comes in green on the screen, then people will have a 'wow'-feeling. The audience sees the lines on the floor, a little bit like electricity cables, you cannot touch it, or go past it. Now they take 1 tenth off if a gymnast goes out of bounce, that is not understandable, they should show something with a led or something else if a gymnast passes the line. And also more deductions. We can make it more exciting. With the technology, we have everything, cameras, and lasers. In soccer with all the cameras above the field, we can perfectly know how much meter a player runs, how much passes he does. So this technology exists, we need to bring this over to gymnastics competitions and use an app. With Spieth Janssen Fritsen we are busy with Swiss timing, to bring more technology in the apparatus, with sensors, so it is coming but it is slow because there is not much demand from the broadcasters. If the broadcasters want something, it will come.

**What do you think of the technology as a tool to judge?**

I think that the technology can really be an added value, but the eyes of judges are very subjective but very special. The problem is for a long duration, if they judge from nine in the morning until nine in the evening, at one point we are all humans, then we have a problem. The system will probably not have that problem, but I have seen at worlds in Stuttgart, they have used it three times and one time it didn't work, so the system is not ready for 100%. But it will help the judges to get a better position. A review is certainly something important, but I see it as a judging panel with judges, and the Fujitsu technology takes the place of just one judge, that is the future. And not that it will all be cameras from Fujitsu, it stays important to judge with humans. I find it important that the technology is used, because it will bring some neutrality, because sometimes.. the FIG has adapted its judging regulations, so if a Belgian is in a final, there will never be Belgian judge judging, so that is positive. But it there is still a lot of subjectivity, we know that there are a lot of judges that are from the old Eastern Bloc, a lot of Russians, and a Russian is always for the Russians, the same with the US. So that is a characteristic of judging, a lot of subjectivity. But it is less than rhythmic gymnastics or synchronized swimming or ice skating, there it is a bigger problem. So that will certainly improve with the system.

But we still need human judges, because of a socket... We work a lot with kids, teenagers or young adults, they train very hard the whole year for one moment of glory, that is at a competition, you are not to make any errors, that is why that there is a panel of five judges where the highest and lowest score are dropped, then we are more or less objective. If there is a problem with a machine, you don't know what happens. I think that it is great that one or two judges are replaced by the technology, but the eyes

of the humans stay very important. The use of the technology will give more stress to the judges to be correct, especially that they cannot base it on feelings like “that was a beautiful routine I will give a little bit more”, no it has to be constant and it needs to be a little bit more objective. So that will certainly help the judges to be consequent and less subjective.

Hopefully, the technology will be less expensive in the future because if you see what happens with the phones now, and with the 5G, everything will be easier for downloads, for exchange of information, for analysis. So it is a constant evolution, I think that the gymnastics world has to catch up in the use of technology. Since the iPad and a few programs that look at analysis of movement, it has begun. But we can go even more deeply, and this type of technology can absolutely support that through recording. You can activate it when you need it, in the gym or even at home, some do gymnastics at home, especially in the coming weeks. The technology can help to correct handstands at home, it is another level, a lower level of technology, but it is maybe also a possibility. We have to enjoy the technology and not despise it.

**Do you think this technology will induce more fans watching/following the sport?**

Yes. When we look at what is happening with Nina, and this system is kind of the same. Nina attracts so much attention and has such a big reputation in the gymnastics world that a lot of people who don’t have an opinion about gymnastics, nevertheless watch gymnastics because it is Nina. And that can be compared to the technology if they understand it, it is easier to understand. Why do a lot of people watch soccer? The rules are easy and everyone can give its opinion, even without knowing the rules, is it in or out, yes or no, is there an error yes or no? Gymnastics is so much more complex, it is a technical sport, you need more background. If you can get that background through the technology, more people will get involved in the world of gymnastics, not only fans but also judges, club members, so that can be positive. It is visual and understandable.

*5. Jean-Luc Deloof (written)*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think gymnastics is on the technology movement like the entire sports world and externs. I am not surprised by this evolution.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

They will be able to obtain very pertinent information thanks to this evolution. Like with every technology, it is very expensive and there is a risk of failure. I don’t understand how it will be possible to keep the artistic character of gymnastics. I think it could bring a veritable revolution to the discipline, but the human aspect of the execution risks to disappear quickly. Principally on apparatus where the artistic aspect is important such as WAG/MAG floor, and balance beam. Going even further I ask myself if the use of music for women on floor will keep being a necessity on floor.

I have big questions on the judgment of the technical aspect of a movement. Who and how will they determine which method is the most appropriate for a movement? In the case of twists, there exist multiple techniques. Why would they chose one technique above another and don't we risk to robotize movements? I don't have enough biomechanical knowledge to do analyses but if they determine the height of a movement, the different boy types of gymnasts won't it have an influence? The height-weight-length relation of the segments isn't identic for everyone. With this technology won't we see gymnasts with different body types disappear? How will they determine who is the right prototype? Nina Derwael or Simone Biles on bars?

**What impact could this technology have on training methods?**

If, as I am afraid of, the artistic aspect will disappear, they will focus more on difficulty and the artistic aspect will decrease. In the future, we could see a complete modification of the movements, especially in WAG. On the other hand, the trainers and gymnasts will be able to obtain information on the correctness of the performances.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts and trainers, yes, there will be a possibility to refine the corrections of the movements and if needed adapt to answer the requirements.

For judges yes and no, there should be no doubt anymore on the realization and execution of movements.

For fans, yes gymnastics is particularly difficult and there will be a possibility to increase the comprehension. On the other hand, they don't have to suffocate the audience with information. Nowadays the majority of spectators watch gymnastics as a spectacle. There should be room left for this aspect of the sport. It isn't all about if there was a goal made or if the ball is in or out.

**Are there other things that might be (more) important to help the sport move forward?**

I think that thanks to this technology we will be able to explain the skills and the specificities of the discipline in an easy way. Also helping the visualization of the movements.

**Are there things that are not important and could be left behind? Why?**

I don't have enough background to judge if something could be left behind but certain disciplines that want to be freer could see them being locked in with this technology. The philosophy of Free Running is being free, and that technology will diminish that if it takes the place of the human in the interpretations of the performances.

**Do you think this technology will induce more fans watching/following the sport?**

Yes, actually the understanding of competition, skills.. it is reserved for an expert public. Through such technologies, they will facilitate that and it could possibly multiply the number of interested persons.

**What do you think judges will think of the technology?**

I think that the judges could be frustrated to be replaced by machines. On the other hand, the influencing game could disappear.

*6. Ilse Hoebeke*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is interesting. I like that they show how long he holds that cross and how high she went on floor. When you see that on television, it goes so fast that you don't know if it was straight or not. So it is helpful. And also to know if it was a double or a triple twist because I don't always see that.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

That the gymnasts will be evaluated more correctly, that the scores will be more correct. If for example, someone is on bars, is she at 90° or 87°, with that system they will see better if it is straight or not, so the points will be more correct.

That it will take longer to get a score if judges want to see the images again and discuss. [The technology would be used at the same time when judges evaluate, they won't have the possibility to watch the recording afterward.] If that is the case, then it is an advantage

What if the electricity falls out during a competition? That can always happen, I think that is a problem.

**Do you think this technology will induce more fans watching/following the sport?**

I don't know. You are a fan or you aren't, I don't think that that technology will attract new fans. Maybe it could be that people who don't understand, will become more a fan because with that additional information they will understand how difficult it is.

For me as a fan it is an added value to know these metrics, I think it is interesting.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For the gymnasts, trainers and judges yes, because they will be able to see in images if the routine was effectively good or not.

I think that it will also be an improvement for the judging. Sometimes when I watch gymnastics on tv and I watch the scores, I do not always agree, even though I don't know a lot about the judges. A judge will

always turn a blind eye if it is a gymnast from its own country competing. So that technology will help for that

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

That is a difficult question. To show more competitions on television, and promote it more. Because now, when do they show it? Only World and European championships, only when Belgian gymnasts are competing. I would watch competitions on television even though there are no Belgians competing.

**What do you think of the atmosphere at the smaller competitions in Belgium?**

I think that the ambiance at the competitions in Wallonia was good in general. Sometimes it is quiet but that is normal, if someone is competing on beam, you have to be quiet, for the concentration of the gymnasts.

**If they broadcasted the Belgian championships on tv, would you watch it?**

Yes, but I don't think I would go to see it live. When the world championships were in Belgium, we went to watch, but that is because it is from a higher level.

*7. Emmanuelle Decoster*

**What is your first reaction after seeing this video and being introduced to the technology?**

It's cool. The scores will be more correct. To me, it seems that it is not something that will be used on the short term, but more for in the future.

For example with Nina, she was in the first subdivision and the judges were fresh, and the more the competition goes by the more tired they are and see fewer errors and are less harsh.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

An advantage is that everyone will be judged the same way. It will maybe also go faster. A disadvantage is that it will cost a lot of money. And another disadvantage is for the dance, how will the technology evaluate that?

**Do you think this technology will induce more fans watching/following the sport?**

I saw in the video that you could watch on your phone where gymnasts lost points. Because people when they watch it, they think it is perfect, but that app can then show where the errors were.

**Do you think that that additional information will attract more people?**

I don't know.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts and trainers absolutely, they can more easily and clearly see where the errors are. For judges, they will lose their jobs. For fans, I am neutral, I don't think it is such a big advantage for them. I think that they will like to see where the errors are sometimes, but I don't think that they are that much interested in it.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

To watch more competitions, for example, if Simone Biles competes, like really good gymnasts. They have to show more big competitions. I don't think that people will be interested to see a provincial preliminary at the B level, nobody will watch it, because it is not such a high level and there is not someone popular at that meet.

The atmosphere at big competitions is nice, because of the big arena, the music. Small competitions are really boring, first because there is a very little audience, second, because it is organized in boring rooms, third, because there is no good music, and fourth, the people that are in the audience are not enthusiastic. In Flanders the competitions are really boring, for example on floor, nobody screams to encourage, in Wallonia that is better. So I think that a better atmosphere will make it more interesting and fun for people to come to watch.

## 2.5 Non-fans

### *1. Margaux Vanhaute*

**What is your first reaction after seeing this video and being introduced to the technology?**

I think it is good, my niece used to do gymnastics, and I found that the scores were pretty subjective. So it is good that it will be objective now.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Positive because it is objective. [Céline: what do you mean by more objective?] Well sometimes it is like the judges say "here I give you a 10" (or I don't know how much points), and with the AI they won't be able to do that. I think that judges sometimes favor gymnasts they like, that they are biased.

I can't come up with something negative. Can the judges still give points, or is it only the technology? [Céline: For now both judges and the technology will be used, but in the future, it is possible that they will completely replace them.] Maybe the sport will get less social at competitions, now there are like multiple roles, and maybe it will be more boring when there won't be judges anymore.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts, they will get the feeling that they are being evaluated correctly. For the judges also because they will be able to evaluate more correctly because of the help of the technology. And for the fans, I don't immediately see an advantage. Yes maybe that they then know that the score is correct and that they won't worry about the score. Sometimes there are parents that can get angry when their kid doesn't have a good score. The fans will more agree with the scores given.

[Céline: In the video, they demonstrated that the fans could see the angles and such on television, do you think this is an added value?] No, I don't think so, maybe for someone who knows everything about it, but for me, it wouldn't be an added value because I don't know how it works, I won't derive anything from the degrees they show. [Céline: This is just the intention of showing these numbers, it is that people would understand it better.] So that they would understand how the scoring works? [Céline: Yes] I just watch gymnastics because I like to see it, but I don't watch to know who is going to win, I am not interested in the scores.
So I think the gymnasts will take the most advantage of it, knowing that they are evaluated correctly.

**Do you find it disturbing not to know how the scoring works?**

Not really, I just watch it because I like to watch the skills, I never watch the scores they get, I just enjoy watching the show.

**Are there other things that might be (more) important to help the sport move forward? Are there things that are not important and could be left behind? Why?**

Football is streamed in pubs, it is like a social event, people come together to watch football. Maybe there should be more communications about the national team, like "The national team is competing this weekend", and that they then broadcast the competition on television. Like now, I wouldn't even know when they compete.

For showing the numbers such as the angles, for me personally, it is not important. But I think it is great for the people that are interested in it, but I am not such a person. I also wouldn't install the app.

**Do you think this technology will induce more fans watching/following the sport?**

I don't know, I think that the fans that already exist, will be able to follow the sport better. And maybe for potential fans that would like to be fans but don't understand the scoring. But for people such as me, I don't think the technology will make me a fan.

*2. Zora De Buyck*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is crazy that this exists and that there is an app that can be useful for everyone, but on the other hand, it may be negative for the gymnasts because every detail is analyzed. I understand that it is gymnastics and that that may be important and everything has to be perfect, but now it is even more strict. And for the judges, they will become useless. But for the gymnasts, it will be handy at trainings that they won't have to videotape themselves, but they will see everything in 3D and better analyze their movements such as a hand that should be placed five centimeters more up. I think it is cool.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

Positive for the gymnasts that they can further improve their performances, with the 3D that they can perfectly see the position of their skeleton and that they can perfectly see how they have to make improvements in their body positions. For the judges too, if they haven't seen anything clearly, they can trust the software, that it has seen everything. That they can verify what they saw with what the technology saw.

Negative, these are cameras you are constantly filmed and being observed. I have some privacy issues, I understand that when you do gymnastics, it is to be seen. What if someone hacks the cameras and films and observes things you don't want.

For the fans, I think it is nice that they can watch the performance on their smartphone but on the other hand people are at a competition and are watching their smartphone instead of watching the performances in the arena. Maybe then can criticize the gymnasts more, for example like "he's arm was 2 degrees below horizontal". But when watching from home I think it can be interesting to have some more information, and that you have a better understanding of how well or bad a gymnast performs. And I think that it is cool to know for example if someone jumps extremely high to know how high because everyone will be like "wow". But I don't think you should be watching your smartphone while you are at a live competition. For the gymnasts themselves, I think the app is good, but for the fans, I think it is unnecessary.

**Do you think this technology will induce more fans watching/following the sport?**

In itself I don't think so because you are a fan or you aren't, I don't think the technology and the app will have an influence on that. If you are in this gymnastics world it can be interesting, but if you don't know anything about it, I don't think that the technology will help you see how someone performs or gives scores will change that. If you don't know what they are doing, I saw a guy performing on that thing [pommel horse], I thought it was super spectacular, but it was maybe a very basic skill. As a non-fan, you don't really know what they are doing and everything seems spectacular, and with the technology saying that was good or bad, or he has jumped that high or not, I don't think it will have an impact for me on starting to follow the sport.

[Celine: the technology wants to explain how they come up with a score, do you think that is useful?] That shot with the column below where they explain the score, in itself, it is cool how they do it, but it was all Chinese for me I didn't understand how it worked. I see a 4.0 so that maybe the score out of 5 points. [Céline: no that's not it. So you don't think that it is an added value?] I think it is an added value for the judges, that they can rely on the technology and that they can compare their scores with the technology and learn from it, it will be more objective for the judges. Maybe for the gymnasts, it is an added value, that they perform their routine in training and that they can see how the technology would score it.
After seeing the video I am not inclined to watch the sport more and I don't think I understand the sport better.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

I think the gymnasts and trainers because they can perform their routine step by step and then can improve step by step what needs to be improved. But for the fans not really, I don't think it is an improvement for them. For the judges that they can measure their scores to what the technology would do and they can both improve. So mainly the gymnasts will benefit from it.

**Do you think this technology will induce more fans watching/following the sport?**

I have never seen gymnastics on television, so they should show it much more on television. I think they probably show big competitions, but even those I have never seen. Or they could also make more movies about it, there are movies about figure skating and hockey, but not that much from gymnastics I think. And maybe more publicity, also for local competitions. For example, gymnasts asking more friends and families to come to watch a competition, and maybe that could lead to more people watching gymnastics on television. I only know Nina Derwael and you but I couldn't name other gymnasts. I don't have the impression that… when watching gymnastics it is like everyone is individual, while football is a team and everyone roots for that team, but in gymnastics, it is like not really a team, it is more individual, so maybe that is a thing that doesn't appeal to people. Cycling is also individual but I don't know, it is much more on television than gymnastics, so maybe it has to be as more of an automatism. Like people say I will watch cycling on tv, while you cannot really say that about gymnastics. I wouldn't even know on which channel they broadcast gymnastics.
So, in general, I would say more communication, more on television and more publicity.

*3. Bart Dutoit*

**What is your first reaction after seeing this video and being introduced to the technology?**

It looks complicated, I don't know if it is something interesting for the athletes. I think it is too precise, and that perfection will be pursued and it will be too difficult. For the judges, it can be interesting. For the spectators, I think it is better to watch at what happens in real life than to look at the app.

**Do you think it will help to better understand the scoring?**

Yes, maybe. I think it is good, especially for the ones that are really interested in it. Who sits in the audience? The parents and family I think they would like to know why a gymnast got a certain score. For them, knowing how the scoring works they will be more involved in gymnastics. But for someone like me, who isn't a fan it won't help.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The positive is for the judges, that they can better evaluate, and if there is a doubt that they can look back, they can justify their judging. The negative is that it will be too difficult for the athletes, that it will be demanded to strive for perfection. The sport should stay fun for them, I think it would be to too strict.

**Do you think this technology will induce more fans watching/following the sport?**

I don't think that this technology will make the sport more popular. It is a very specific sport, I think it is only for people who are really interested in it, but I don't think it will attract normal spectators. It will be interesting for the parents and the people who really like the sport and are invested in it. Gymnastics is not such a big sport, I think there is also less money involved in it. Maybe if there was more money, it would attract more athletes. A lot of athletes choose to do tennis because it pays well.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

I think for the real fans, the die-hards it is interesting. And especially for the judges and also the athletes, this technology is good to enhance their performances. But to attract a big audience, I don't think so.

**Are there other things that might be (more) important to help the sport move forward?**

The salary. A popular Belgian like Nina Derwael could also stimulate it, if she is at an event she can attract more people to come. Also, television, showing more gymnastics will also help to make it more popular. It was the same for cyclocross, that was a small sport, it has received more attention from the media, so it got more attractive for people to follow and know it has grown a lot.

*4. Fred Catteau*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is impressive that they can bring this level of technology to gymnastics, for the competitions and also for trainings. I think that this is something that could help trainers to enhance the way of training and the quality of the skills of the gymnastics. For the spectators it could help them to have a better appreciation and to understand what they see, and also that there will be less cheating, that it will be more rational, everyone will be judged the same way. And for the judges, when you see competitions, it goes so fast,

you ask yourself how it is possible for them to notice everything that is done within one or two seconds. And with this technology, it is not possible to have errors.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The advantage is that everyone is judged the same way because the human will practically not interfere in the judging anymore. Ans also that the machine can help trainers to ameliorate the training.

The disadvantage is that they rely on informatics and that the human intervenes less, so that could bring disadvantages. We can think that something is good, while the computer says it is not good, so maybe that it is esthetically more pleasing but that the computer sees it differently.

**Do you think this technology will induce more fans watching/following the sport?**

Maybe yes, especially the ones that are interested in technology in sports. They could get more interested in something they first didn't understand in the past but that today can visualize with the aid of the technology and informatics.

**Do you think it will help to better understand the scoring?**

For the ones that are in gymnastics, it will allow them to have more objective evaluations. For persons who aren't a fan of gymnastics and don't really know what happens with a score, I am not convinced that it will change something. Maybe yes but it is difficult to judge, it is still in an experimental phase. Will it attract people who aren't fan to like gymnastics, I don't know maybe that it will persuade more young people who are busier with technology.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

If look on a Belgian scale, the fact that we have Nina Derwael, high-level athletes, will make that we get more interested in the sport. We have seen that with hockey in Belgium, 10 years ago it was something that people weren't really interested in, now we are. Now that we have come to a great international level because of investments, we see today that people get more interested, when it is on television or when there are big competitions. Gymnastics, we already see it more on television than in the past. So the media and the investment to bring the athletes to a higher level will help. It is like the women's basketball team, we now have a high-level team, because they have invested in it.

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

I think so. I would say that the judges and the athletes will take the most advantage of it. For the judges, I can imagine that judges have difficulties to see everything and to come up with the right score, or that

they don't agree on what has been seen or not. For the athletes, with the technology, they could improve some skills and have more high-quality performances.

I don't think that the fans will get as big of an advantage.
For me as a non-fan, it will help to understand more what is happening, to see how the scores work. But we don't have the basics of the deductions and skills so that will not change, but with this, we can visualize a bit more how it works.

**Do you find it a problem that you understand the scoring?**

Yes and no. We know that there always is some subjectivity. When you see two same vaults, you think that the first was better, but eventually, it is the second one that has a better score. But there are all small things that I don't notice because I am not a specialist and judges are. So that technology will help to understand it a little better.

*5. Sébastien Catteau (written)*

**What is your first reaction after seeing this video and being introduced to the technology?**

It is an excellent thing to support certain decisions of judges, but it cannot replace them. They will lose the human factor which stays important, we are not machines. We should maintain the beauty of the sport in general, but it is great to enhance and maybe avoid injuries and also inequalities in the judging where maybe some judges like or don't like a person.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

As I said, it is a wonderful tool to support human decisions, as the movements are quick it is important to be able to break down and analyze them, which is possible with this technology. As advantages, the speed of decisions, the equal treatment, the enhancement of performances of the athletes, avoidance of injuries, aid to help the uninitiated audience to understand some decisions of the judges. As a negative, the fact that they want to replace the judges with the technology, it is not ethical, the human doesn't have to be judged by machines, we aren't robots.

**What impact could this technology have on the attraction of fans?**

Maybe an improvement in the comprehension of the decisions?

**Fujitsu claims that the technology could be an improvement for trainers and gymnasts, as well as judges and fans. Do you agree? Why (not)? Who takes the most advantage of that technology?**

For gymnasts and trainers, it will improve the performances, diminish the risk of injuries. I think that it is the gymnast that is being judged who will take the most advantage of it because he will be able to improve and avoid injuries and being judged fairly.

For judges, the fairness of judgment, au judge won't be able to say that a gymnast has failed a skill (even sometimes with wrong intentions if he doesn't like the gymnast) because the others could contradict thanks to the evidence brought by the technology.

For the fans a better comprehension of the decisions of the judges.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

Because it is a passion, you cannot force someone to love it, even with a technology. I think it is a question of culture and education. A kid who grows up in the world of this sport will consequently be interested while another kid not. I don't think something has to be ameliorated, you have to keep the beauty of the sport.

**Do you think this technology will induce more fans watching/following the sport?**

No, because the sport is a question of love and interest, it is a passion, it is not a technology that will make me like gymnastics.

*6. Ivan Claeys*

**What is your first reaction after seeing this video and being introduced to the technology?**

That the judging will be more correct, there won't be derogations or preferential treatment anymore. I assume that there is some preferential treatment within the judges, judges that have to judge someone of their own country or judges that are friends and give each other benefits. If it is used, everyone will be treated the same way.

**What do you think of the technology? What do you think is positive and negative? What could be the advantages and disadvantages you can come up with? Why?**

The biggest advantage is that it will be the correct person that wins and that there won't be that much discussion anymore, it will be the same for everyone. The humans will be replaced, which is an advantage.

The disadvantage will be the price probably, that small gyms or federations won't be able to pay it. But it is like the first microwave that was very expensive, but now everyone has one. Ones it is established and used massively, it will get cheaper. And maybe it could become an obligation at all gymnastics competition.

**Do you think this technology will induce more fans watching/following the sport?**

That is something else. Yes, probably that people will watch it more because they will have more faith in the results. I think that the biggest advantage will be that everyone will be judged the same way. For example, if you have 50 people to judge, at the beginning you will judge and make sure that if better

people are following you can give more points to them, but if the first one is really great, he will get a good score because he performs as first, in contrary to the fifteenth, and to that fifteenth person you will more easily say that it was great and give a big score, and take that as your reference performance. It is the same for either context of judging, when the first starts, it is always the most difficult to evaluate because if someone better comes after, you have to be able to give a better score. With this technology, everyone will be judged the same, the draw of when you are being evaluated won't influence the way you are judged. Now it is the case that the draw influences how you are evaluated. Also for example, if there were two weaker persons, and then a greater person gets evaluated, he will get a bigger score than for example the very first person that was judged, who performed even better. And so for that, it will be a big advantage.

There will also be a lot more people who will understand the sport if they get that additional information while watching. A layman who watches will say that he preferred one routine, that could be because of his leotard, or his looks, but in fact, you don't know how the scores are given. So that additional information will be very helpful.

I prefer that technology to the VAR. Here it is the technology that says everything, that isn't the case for the VAR in soccer because there the people have to intervene to use the VAR. Here the technology is used for the whole competition for everyone, the use of the VAR in soccer is a choice that someone makes.

So I can imagine that it would stimulate more people to watch because they will understand it. You can justify the scores on the television screen. People will be less skeptical about the scoring. Now a lot of people know or think that big countries such as Russia, the USA, and China get advantaged, and that could be a reason why people don't watch because they are like 'we already know who is going to win, these countries always win'. Those are also bigger countries with more athletes, I think it will be an advantage for smaller countries who have great gymnasts, they will have the same chances as the gymnasts of the bigger countries, and that is an advantage.

**How could the sport ameliorate in terms of fan engagement? Are there other things that might be (more) important to help the sport move forward?**

It will always be a sport that not everyone can do. And when you cannot perform it, you are less tended to watch it, as to a sport that you perform yourself. Everyone can play soccer, everyone can shoot on a ball, but not everyone can hang on a bar or spring on vault. So automatically that will motivate fewer people to watch.

It will make itself more popular, as an audience, when you watch and can better understand how it works. Today a lot of people don't understand why someone wins, while they thought that someone else was better, the technology will explain what the differences are. There are a lot of sports today such as baseball and basketball that a lot of people don't watch because they don't understand how the scoring system works, or why someone throws a ball in after 10 or 30 seconds.

## Appendix 3 – Nodes Nvivo

- Achievements
  - Sponsorships
  - Salary
  - Investment
- Better understanding
  - App
    - Live event
    - At home
  - More information/explanation
    - Speaker at competition
    - On broadcast
    - Screens at competition
    - Not too much info
- Fan engagement
  - People won't care
  - Will attract
    - Fans
    - Fans and new people
  - Won't attract
- Judges
  - (Fear of) losing job
  - Judging panel (technology)
    - Both D & E
    - Only D
    - Still need judges (D & E)
  - Problems
    - Different techniques
  - Reference tool
- Media
  - Broadcast
  - More communication/advertising
  - More in the news
  - Perception
- Other factors
  - Atmosphere
    - Longevity
    - Perception of having to be quiet
    - Show
  - Competition format
  - Injury prevention
  - Rules
- Outcome acceptance
- Pro/contra
  - Contra
  - Pro
    - Advantages
    - Future
- Problems
  - Artistic aspect
    - Judges needed
    - Technology can judge artistic aspect
  - Body type
  - Cost
  - Too precise
- Procedural fairness
  - Accuracy
  - Bias
    - Nationality bias
    - Reputation bias
    - Sequential bias
  - Cheating
    - Measures against cheating
  - Human-related factors
    - Fatigue
    - Human eye
    - Stress
    - Subjectivity
      - Human touch
      - Keep subjectivity
      - Reduce subjectivity
  - No discussion
  - Viewing position
- Training methods
  - Focus on D
  - Focus on E
  - Helpful
  - Not (very) helpful