

The legitimization of performance-enhancing equipment in sports

A case study on skinsuit implementation in Olympic sports



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ABSTRACT

Introduction

It is commonly accepted that technological innovations in sports have dramatically improved athletic abilities and are crucial for maximizing performance for both individuals and organizations. Although innovations have improved performance in a number of sports, they also play a controversial role. To better understand these controversies this research looks into the process of legitimization of performance enhancing equipment innovations from an institutional perspective by combining concepts of Strategic Action Field theory and innovation processes.

Theory

Strategic Action Field (SAF) theory describes three phases fields go through in resolving controversies and define actor roles present in the field; dominant actors, challengers and governance units. Innovation theory adds to this by distinguishing, users, producers and institutional actors. Within a field actors act strategically to maintain or strengthen their position in the field. During contentions these actors engage in strategic action to influence the legitimacy of new technologies. To better understand these processes this research distinguishes between three types of legitimacy and describes five strategies actors use to influence this legitimacy.

Methods

This research used a comparative multiple case study design looking into skinsuit usage in Skeleton, Cycling and Swimming. News articles and internet data were used as primary data sources for analysis. For each case the analysis consisted of five consecutive steps; open coding of the data, drafting a timeline, actor role analysis, legitimacy analysis, and a strategy analysis. Lastly, all cases were compared based on the preceding analytical steps. These steps are further elaborated on below.

Results

All three cases followed different timelines. In all cases new technologies were introduced by a dominant actor through a user-producer interaction while opposition came from both dominant and challenger actors. Furthermore, in all cases the success and the visibility of new technologies showed to trigger contentions. During contention all actors engaged in strategic actions, framing and theorization was mostly used as a strategy. Eventually cognitive legitimacy showed to have the most influence on settling these contentions.

Discussion

This research combines insights from both an innovation and institutional perspective to provide a better understanding of the legitimization process of technological innovations in elite sports. A new model integrating these perspectives with SAF theory is introduced to add to this understanding by showing how strategic actions and interactions between field actors influence this legitimacy. Furthermore, directions for future research to test and add to this model are discussed.

1 INTRODUCTION

It is commonly accepted that technological innovations in sports have dramatically improved athletic abilities and are crucial for maximizing performance for both individuals and organizations (Balmer et al., 2012; Ringuet-Riot et al., 2013). Technological innovations in elite sports mainly relate to the development of improved equipment and new ways of monitoring performance (Tjønndal, 2017). It is expected that improved athletic performance will be even more dependent on technological advances in the near future (Lippi et al., 2008). Olympic records have remained rather stable and other positive influences on performance such as professionalization, increased participation and improved training and nutrition are starting to reach their limit (Balmer et al., 2012).

Although innovations have improved performance in a number of sports, they also play a controversial role (Loland, 2009; Trabal, 2008; van Hilvoorde et al., 2007). Especially sport equipment that enhances performance is often seen as unfair since they provide an athlete an 'artificial' or 'unnatural' advantage over competitors (Loland, 2009; Richard et al., 2020). This poses a problem for sport authorities, as fairness is an essential value in competitive sports and they are in place to ensure this value (Carstairs, 2003; Loland, 2009; Richard et al., 2020). Therefore, sports authorities can be reluctant in accepting these new technologies (Ringuet-Riot et al., 2013; Trabal, 2008) and in some cases they even get banned to ensure fairness in competitions (Richard et al., 2020). For example, authorities banned the Nike Vaporfly that enabled an athlete to run a marathon in under two hours, and the double-strung tennis rackets because they provided too much advantage (Dyer, 2020; Richard et al., 2020).

Dyer (2013, 2015, 2020) attempted to provide a framework for understanding the acceptance of performance enhancing technologies in sports. To do so, he conducted a literature review on a range of studies regarding controversial innovations in sports and proposed ten factors¹ influencing their acceptance. However, looking back at the case of the Nike Vaporfly this framework already proved insufficient (Dyer, 2020). Dyer (2020) concluded that the presented arguments against the Vaporfly were not substantial enough to justify the ban. This shows that the acceptance of performance-enhancing equipment cannot solely be understood by this framework which only discusses the content of arguments. During contestation of technologies not only the content but also the underlying processes, such as what actors are involved and how these actors engage in strategic action, are important for the eventual outcomes (Battilana et al., 2009; Kaplan & Tripsas, 2008). These processes are not included in Dyer's (2020) factor framework possibly explaining why this framework is not sufficient. Ratten (2020) also states that despite the dominant usage of technology on sport there is still a lack of understanding about the processes regarding the use of technology from a multilevel perspective involving different institutional actors. Van Hilvoorde et al. (2007) touches upon this process and shows that in the case of the klapskate arguments similar as raised by Dyer (2020) fueled discussion on the matter. But, eventually the influence of a powerful user group, the Dutch speed skating team, settled the discussion (van Hilvoorde et al., 2007).

Prior studies thus suggest that the process leading up to (non-)acceptance seems to be of relevance, yet this process remains unclear in the context of performance-enhancing equipment in sports. This process can be seen as the legitimization of the technology, since for the

¹ Ten factors influencing the acceptance of innovations in sport: 1) Harm or health risks, 2) Un-naturalness, 3) Unfair advantage, 4) Coercion, 5) Concerns for safety and spectator appeal, 6) Deskillng and reskillng, 7) Dehumanization, 8) High costs, 9) Challengng internal goods of a sport and 10) Unequal access (Dyer, 2013, 2015, 2020).

acceptance of a new technology, its perceived legitimacy is crucial (Battilana et al., 2009). *Legitimacy* can be defined as '(...) a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions' (Suchman, 1995, p.574). Institutional theory conceptualizes these socially constructed system of norms, values, beliefs, and definitions as *institutions* (DiMaggio & Powell, 1983). Institutions, to stay in the terms of sports, can be defined as 'the rules of the game and organizations and their entrepreneurs are the players' (North, 1994, p.361).

Literature embracing actors agency, argue that institutional actors actively try to influence this legitimacy through strategic actions (Battilana et al., 2009; Fligstein & McAdam, 2011; Geels & Verhees, 2011; Pacheco et al., 2010). To better understand this Fligstein & McAdam (2011) combine insights from sociology with organizational studies regarding collective strategic actions aimed at influencing the legitimacy of new practices in a particular field. They view organizational fields not as settled or stable, but argue fields are naturally contentious. They define the concept of Strategic Action Fields (SAFs) and focus on the emergence of new fields and fields in crisis. They discuss critical elements, such as actors position within fields and strategic actions to understand these contentions within fields.

Controversies in fields generally occur by external shocks originating from other SAFs, actions of the state, entrance of other groups of organizations or large scale crises such as wars or depressions (Fligstein & McAdam, 2011). In sports, controversies are often triggered by the introduction of new technologies, which is not clearly defined in SAF theory. New technologies are inherently uncertain, and users, producers and institutional actors are likely to have conflicting understandings of these new technologies (Kaplan & Tripsas, 2008). Contentions are an essential part of the process of coming to a collective understanding of these new technologies. During these contentions users, producers and institutional actors purposely act and interact to shape these collective understandings regarding technologies (Kaplan & Tripsas, 2008). However, it remains unclear how these interactions are shaped and how these influence technological innovations (Kaplan & Tripsas, 2008). SAF theory provides a framework to better understand these interactions during contentions and can therefore lead to insights in the legitimization of performance-enhancing innovations in sport. Consequently, this research aims to answer the following research question:

How do strategic actions by users, producers and institutional actors influence the legitimization of performance-enhancing equipment in elite sports?

To uncover this process and identify patterns, an explorative multiple case study regarding performance-enhancing equipment was conducted. To be able to identify patterns, similar cases were compared (Bryman, 2016), specifically the use of skinsuits in elite sports. In sports aimed at covering a certain distance as fast as possible reducing aerodynamic drag is crucial (Oggiano et al., 2013). Skinsuits have shown to be effective in reducing this drag in multiple sports, such as cycling, speed skating and skiing, but have also lead to controversy (Crouch et al., 2017; theflagfinder, 2012) making them suitable for this research. The next section further elaborates on the aforementioned theoretical concepts and combines these in a conceptual model. Following, the method section describes the data collection and the operationalization of these theoretical concepts. Then the results of the analytical steps are discussed, followed by a summary and case comparison. Lastly, the discussion proposes a new model integrating used theoretical concepts and insights gained from this research and puts this in the perspective of existing literature.

2 THEORY

Institutional theory first got ground with the work of DiMaggio & Powel (1983) on organizational field, isomorphism and legitimacy. Institutional theory mainly focusses on organizations, institutional stability and change, so to better understand the underlying processes of controversy, theory on strategic action is additionally used. This section will further explain relevant concepts such as *legitimacy*, *agency* and *strategic action* in the context of sport and performance-enhancing technologies to help guide the case analysis.

2.1 INSTITUTIONAL THEORY

Washington & Patterson (2011) discuss key tenets of institutional theory based on a literature review by Greenwood et al. (2017). Firstly, they state that organizations are influenced by their institutional context and that institutional pressures affect all organizations. This causes organizations to make certain choices not necessarily from an efficiency rationale but based on gaining or maintaining legitimacy in their institutional context. What is seen as legitimate is socially constructed and based on shared norms, values and beliefs among actors (Battilana et al., 2009; DiMaggio & Powell, 1983; Scott, 2001). Practices that are seen as legitimate can become institutionalized by repetition within the field and acting in line with the institutional context can in turn provide legitimacy for organizations (Washington & Patterson, 2011).

2.1.1 Legitimacy & Agency

Multiple studies distinguish different types of legitimacy with slightly different conceptualizations (Binz et al., 2016; Scott, 2001; Suchman, 1995). This research follows Suchman (1995) since it provides a clear conceptualization with little overlap between the legitimacy types making it suitable for operationalization. Suchman (1995) distinguishing three types of legitimacy; *pragmatic*, *moral* and *cognitive legitimacy* which can be linked to the use of performance enhancing technologies in sport. Pragmatic legitimacy relates to self-interest of actors. Pragmatic legitimacy focusses on the practical benefits of a certain activity or use of a technology for a given actor. Moral legitimacy reflects a normative evaluation of the use of the technology and is based on whether an activity or in this context using the technology 'is the right thing to do'. Cognitive legitimacy relates to whether the use of a technology fits with cognitive beliefs and definitions and the taken-for-grantedness of these beliefs and definitions, cognitive legitimacy is generally the most powerful source of legitimacy.

When legitimacy comes from conforming to existing structures and institutions, little room is left for actors' *agency*, which refers to the ability of actors to influence their environment. This poses a problem for understanding the (de-)legitimization of new technologies from an actor perspective (Battilana et al., 2009; Geels & Verhees, 2011). Others depart from this structuralist approach and leave more room for this *agency* by viewing actors not only as passive agents that follow existing structures, but stress their ability to reflect and act upon institutions (Battilana et al., 2009; Benford & Snow, 2000; Geels & Verhees, 2011).

Both agency, and moral and cognitive institutions become important for creating legitimacy when technologies are introduced in a field (Kaplan & Tripsas, 2008). Initially sport authorities are expected to decide whether use of these technologies are legitimate or not based on regulatory structures (Vamplew, 2007). However, for authorities it is impossible to provide an all-encompassing regulatory framework and to anticipate all possible innovations and their consequences (Gelberg, 1998). Because of this, regulators often react to new technologies in an

ad hoc manner, providing room for actors' agency and the opportunity for them to engage in collective sensemaking (Gelberg, 1998). Collective sensemaking is based on moral and cognitive institutions and is a process where multiple actors interact and debate over specific issues (Geels & Verhees, 2011). They add to this collective sensemaking by linking discourse to performances. Performances are actions that are performed on a certain stage to influence a specific audience to convince them of something's legitimacy. This focuses on influencing attitudes and opinions of key actors, such as sport authorities. This is also proposed by Battilana et al. (2009) and Pacheco et al. (2010) who showed that actors not only reflect on institutions but also actively influence them to favor own interests.

2.1.2 Strategic Action Fields

Fligstein & McAdam (2011) also argue that actors are always acting strategically promoting their own interests, even under stable institutional conditions. To better understand this Fligstein & McAdam (2011) combine insights from sociology with organizational studies regarding collective strategic actions aimed at influencing the legitimacy of new practices in a particular field. They view organizational fields not as settled or stable but argue fields are naturally contentious. Meaning there is a constant interaction between actors who act based on their interpretation of the field and of others. They define the concept of Strategic Action Fields and define critical elements to understand processes of change and stability in these fields; 1) *Strategic Action Fields*, 2) *Incumbents, challengers and governance units*, 3) *Social skill*, 4) *The broader field environment*, 5) *Exogenous shocks, field ruptures and the onset of contention*, 6) *Episode of contention and* 7) *Settlement*. Because of the emphasis on controversies this theory provides a good basis to better understand controversial technologies. Furthermore, in sports, sport authorities are key actor in the legitimization process of performance-enhancing technologies, the conceptualization of governance units provides a suitable distinction from other field actors to better explain and understand their role.

A Strategic Action Field is defined as '*a meso-level social order where actors (who can be individual or collective) interact with knowledge of one another under a set of common understandings about the purposes of the field, the relationships in the field (including who has power and why), and the field's rules*' (Fligstein & McAdam, p.3, 2011). SAFs all have their own institutional context in which actors operate. In settled SAF actors share consensus over what is going on in that field and there is a shared understanding of the 'rules' in the field and what actions are legitimate (Fligstein & McAdam, 2011). These fields can vary in size and one big SAF can consist of multiple smaller SAFs, for example, a sport can be organized nationally and all actors involved comprise a SAF, but at the same time these actors are also part of a larger field organizing the sport internationally. This also means that the debate on the legitimacy of performance enhancing innovations in sports can take place on multiple levels. This research looks at one particular technology per field of sport but for example, discussions regarding the acceptance of technologies in sport in general would take place on a higher level field consisting of all sports.

In Strategic Action Fields, actors occupy a certain position in the field (Battilana et al., 2009; Fligstein & McAdam, 2011). Actors at the centre of the field generally possess more power, these *dominant* actors heavily influence the field. The purpose and organization of the field heavily reflect their interests, rules tend to favour and the shared understanding of the field legitimize their position in the field (Fligstein & McAdam, 2011). Actors who possess less power are more at the periphery of the field (Battilana et al., 2009; Fligstein & McAdam, 2011). They generally follow field rules but their position does allow them to interpret the field differently providing the possibility to sense opportunities to *challenge* current field structures. Actors will tend to see

the actions of others based on their own position in the field. In most fields, *dominant* actors will interpret actions based on their view of the field, while dominated or *challenger* actors will have an 'oppositional' perspective (Fligstein & McAdam, 2011).

The theory predicts that dominant actors will engage in strategic actions to maintain the status-quo while challengers will generally engage in actions opposing this view. The ability to engage in these strategic actions are dependent on the *social skill* of the different actors in the field. *Social skill* is defined as the cognitive capacity of strategic actors to read their environments and define and their actions based on found a collective interest. So for strategic actions to be effective it is important to take institutional contexts into consideration (Battilana et al., 2009; Hoogstraaten et al., 2020; Pacheco et al., 2010). Dominant actors are generally perceived to be more persuasive (Benford & Snow, 2000) and can use their superior resources to shape institutions in their favor (Battilana et al., 2009; Beckert, 1999). However, *social skill* is not necessarily reserved for dominant actors. But in stable SAFs dominant actors are aided by the shared understanding of other actors in which their dominant interests are defined (Fligstein & McAdam, 2011).

Apart from dominant actors and challengers, SAFs can also have formal *governance units*. Governance units are internal to the field, in contrast to external state actors, who possess power over multiple fields. They facilitate the functioning of the system and ensure compliance with both formal and informal field rules. Governance units are not neutral, they generally safeguard the dominant logic and interests of dominant actors. Governance units are therefore conservative during contention. In sports the role of governance units will mostly be fulfilled by sports authorities, as they act as governing bodies that set rules and regulations for the field (Carr, 2008; Vamplew, 2007). External state actors are not expected to be highly involved within the context of sport since governments have gradually retreated from direct involvement in sport governance (Pendlebury & Semens, 2011). As mentioned, sports authorities often react in an ad hoc manor to new technologies and absence of intervention from a governing body increases the attention paid to innovations (Dyer, 2015; Gelberg, 1998).

Furthermore, these governance units also influence the innovation process regarding performance enhancing equipment, since their regulations define the possible directions for innovations (Gelberg, 1998). Gelberg (1998) furthermore states, that when certain innovation trajectories are accepted it is difficult for these governance units to intervene at a later time. An illustrative example is provided by the Prince tennis racket. The International Tennis Federation remained silent with regard to its legality while it became the most popular racket. Therefore, even though later refinements of the racket revolutionized the elite competition, it was difficult to ban afterwards (Gelberg, 1998). This shows the path dependence of governance unit decisions. Kaplan & Tripsas (2008) emphasize the influence of institutional actors such as governance units on these innovation trajectories. They also acknowledge this path dependency in these trajectories but also state that actors are capable of strategic actions affecting these trajectories. Kaplan & Tripsas (2008) additionally distinguish users and producers as strategic actors that interact with institutional actors during this process. Users and producers might have different understandings of new technologies and therefore might act differently during contentions.

2.1.2.1 *Contention*

When the introduction of new technologies or practices trigger strategic action by other actors this can be defined as the *onset of contention* (Fligstein & McAdam, 2011). This is followed by the episode of contention where field actors interact under a shared sense of uncertainty regarding field rules. Contentions are an essential part of the process of coming to a collective

understanding of these new technologies, during which users, producers and institutional actors purposely act and interact to shape these collective understandings (Kaplan & Tripsas, 2008), eventually resulting in *settlement* (Fligstein & McAdam, 2011).

The *onset of contention* is a contentious result of a process of interaction of at least one *dominant* and one *challenger* actor. Three mechanisms shape the process of the onset of contention. First, a threat or opportunity for the realization of group interest is identified by one or more field actors. Second, resources are mobilized to act on this perceived threat or opportunity. Last, an actor engages in innovative action in defence or support of group interest. This innovative action is from now on referred to as strategic action to better fit with definitions from institutional theory. In the context of this research this strategic action onsetting contention entails introducing a new technology. When this action goes against field rules it is expected that others will respond accordingly, commencing an *episode of contention*. As described in the introduction, introducing new sports equipment is usually done with the aim of maximising athletes performances, and its controversial role shows this often leads to *episodes of contention*.

An *episode of contention* is marked by a shared uncertainty over field rules and a sustained mobilization from both *dominant actors* and *challengers*. This uncertainty often leads to the contention to feed on itself since actors become more conscious of taken for granted rules and question their perceived benefits. During these episodes of contention, dominant actors usually defend the status-quo and challengers are likely to engage in innovative action to improve their position in the field. Episodes of contention can be as long as uncertainty remains. Through sustained mobilization of the opposition or reassertion of the status quo, a SAF can go to a new institutional *settlement* where there is again a shared consensus and certainty over field rules. When contention is about the legitimacy of new performance enhancing technologies in sport, *settlement* is reached when this legitimacy is decided upon by the field. When governance units decide on new regulations to ban certain new technologies, this settlement can also impact the innovation processes within that field. In tennis for example, spaghetti strung rackets were banned, but the door for other innovative racket designs was left open, steering innovation processes in another direction (Gelberg, 1998).

2.1.2.2 *Strategic actions*

SAF further focusses on the emergence and (de-)stabilization of strategic action fields but lacks clear definition of strategies actors employ during these times. Fligstein & McAdam (2011) shortly describe how incumbents and challengers act in these times of change. They mention framing as one form of action used during contention. Furthermore, they discuss that incumbents will remain conservative and will try to mobilize state actors to enforce their view, while challengers are expected to create a large collective identity to become legitimate.

Literature on institutional work further elaborates on strategies applied by institutional actors to create legitimacy for the use of new technologies. Pelzer et al. (2019) identify five strategies to implement institutional change based on the literature review on institutional work of (Pacheco et al., 2010); 1) *Framing* is defined as actors giving meaning to a certain phenomenon, in this case sports equipment on public stages with the aim to promote a shared interpretation favourable to them (Battilana et al., 2009; Bedford & Snow, 2000; Geels & Verhees, 2011; Pelzer et al., 2019). 2) *Theorization* goes further than framing and provides an interpretation of how an innovation should or could function in a particular context. It elaborates on a chain of cause and effects regarding the implementation of the innovation in that particular context. 3) *Collaboration* refers to actors involving other stakeholders to pursue their own or collective interests (Battilana et al., 2009; Pelzer et al., 2019). 4) *Lobbying* occurs when actors try to get political power on their

side, particularly when regulatory changes are aimed for. 5) *Negotiation* occurs when an actor tries to come to an agreement with another stakeholder to reach consensus regarding the new technology (Pelzer et al., 2019).

2.2 CONCEPTUAL MODEL

The aforementioned theoretical concepts are integrated in a conceptual model depicted in Figure 1. This process model depicts one specific controversy within an SAF. In SAFs institutional change occurs through multiple episode of contentions but this research specifically looks at one controversy per SAF to better understand the dynamics during these contentions.

This research will provide insights in the field level conditions and strategic actors present within the SAF and the evaluation criteria for legitimacy. Furthermore, it will look into the onset of contention, the strategic actions by actors during contention and the settlement in formal institutions. By comparing cases from different Strategic Action Fields with different settlements this research provides the ability to identify differences and similarities in the legitimization processes. The next section will further elaborate on specific cases regarding the use of skinsuits and the methods used for answering the research question.

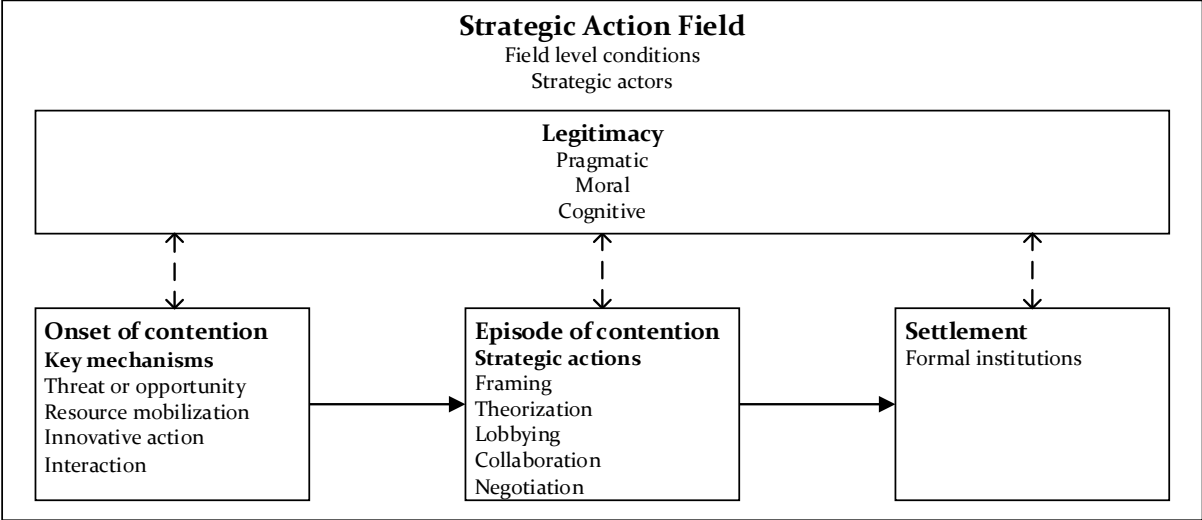


Figure 1 Conceptual model

3 METHODOLOGICAL STEPS

3.1 RESEARCH DESIGN

This research explores the legitimization of new performance-enhancing technologies in elite sports using a comparative multiple case study design. A multiple case study puts the research in a position to test theory but also leaves room for suggesting concepts for emerging theories (Bryman, 2016). Furthermore, case studies are suitable for exploratory research and enable the unraveling of processes (Geels & Verhees, 2011). This section further elaborates on the methods for case selection and provides a small case description. Furthermore, the data collection is elaborated upon and the final corpus used for analysis is discussed. Lastly, five consecutive steps for data analysis and the operationalization of theoretical concepts is elaborated upon.

3.1.1 Case selection

To answer the research question, three cases were selected using a purposive, criterion sampling approach. This means cases were selected based on their suitability to answer the research question based on set criteria (Bryman, 2016). To be able to compare cases similar cases should be chosen (Bryman, 2016). Furthermore, cases should entail some degree of controversy to be relevant for this research. As mentioned in the Introduction, in sports aimed at covering a certain distance as fast as possible, reducing aerodynamic drag is crucial (Oggiano et al., 2013). Skinsuits have shown to be effective in reducing this drag in multiple sport fields but have also lead to controversy (Crouch et al., 2017). Because these skinsuits are similar in technology and impact (reducing aerodynamic drag), are used across multiple sports and have led to controversy, they are suitable for this research. To ensure data availability and to further increase comparability, cases regarding Olympic sports where speed and aerodynamics are crucial, were selected.

To identify suitable cases an open internet search was done with the search words shown in Table 1 which are based on Dyer (2015) and the Olympic sports. Found results were looked into to determine whether there was any case of controversy surrounding the use of a new skinsuit before finally including the cases in the analysis. Below a short description of the included cases is given.

Table 1 Search terms for case selection

Keyword	AND	AND
Skinsuit, Sharksuit, Speedsuit	Controversy, Introduction, Olympic, Ethics, Innovation, Fairness, Advantage, Enhancement, Technology, Ban	Cycling, Skiing, Skeleton, Sprint, Swimming, Speed skating, Running

Speedo's LZR Racer in swimming

At the Beijing Olympics in 2008 Speedo introduced the LZR racer, a revolutionary skinsuit that helped break over one hundred and thirty world records (Kessel, 2008; Wilson, 2008). Full body swimsuits were already introduced in the year 2000 right before the Olympic games, where some

parties already questioned their legitimacy, but the Fédération International De Natation (FINA) tested and approved the suits (Clarey & Tribune, 2000). But the LZR Racer was a turning point because of its enormous impact on the sport. Eventually causing the FINA to ban polyurethane-based full body swimsuits from 2010 onwards (Crouse, 2009).

Great Britain's skeleton skinsuit

For the 2018 winter Olympics in Pyeongchang, team Great Britain introduced a custom skinsuit making them dominate the practice runs (Ingle, 2018a). Because of this, a former world champion questioned their legality, stirring a discussion (Al-Samarrai, 2018). The suits were said to have drag-resistant ridges which would be illegal according to international standards. But both the British Olympic Association and the International Skeleton Federation approved the suits (Al-Samarrai, 2018).

Sky's 'Vortex' speed suit in road cycling

In the 2017 Tour de France, team Sky wore new 'Vortex' skinsuits with panels and dimples to improve airflow past the arms and shoulders (Fotheringham, 2017a, 2017b). Tour rivals questioned the legitimacy and legality of the suits but Tour commissaires validated their legality (Fotheringham, 2017a; Ryan, 2017). However, for 2019 the Union Cycliste Internationale (UCI) updated their equipment regulations making the 'Vortex' suits illegal (Evans, 2018).

3.2 DATA COLLECTION

3.2.1 General

For this research two types of data were used; documentary data in the form of news articles and internet data. This data is suitable since it can provide insights on events without interference of present-day interpretations (Rasmussen et al., 2017). The data was collected using a sequential purposive sampling approach. Meaning, data was collected in a strategic way to ensure relevance for answering the research question and the corpus is gradually added on to ensure all relevant perspectives are taken into account (Bryman, 2016). The researcher has evaluated found data on its relevance and decided on its inclusion for analysis. Criteria for inclusion were whether the source provided information on 1) the development of the specific skinsuit, 2) events regarding the specific skinsuit, 3) claims and opinions regarding the specific skinsuits, 4) performances of users of the skinsuit, and 5) field actors and actor roles. Data saturation was reached when further data-collection did not add anything new to the overall story (Saunders et al., 2018).

Data was collected in three consecutive steps. The first step entailed collecting data from Nexis Uni. Nexis Uni is a database for Universities containing published articles from a variety of international news sources (LexisNexis, n.d.). Secondly, Google search function was used to add to the data found on Nexis Uni to provide a more complete corpus. Thirdly, sources deemed relevant, such as magazines, blogs or sports authorities websites were selected from the previously found data and scanned for additional data. By using this three steps approach data could be collected in a transparent and systematic way leading to a corpus sufficient for analysis. Furthermore, by scanning all data sources before inclusion a general overview of the discourse of the cases was obtained, guiding further analysis.

The search strategy for all three steps was tailored per case. The timeframes for each case were chosen according to the year of introduction of the technology up until the year a definitive decision was made by sport organizations regarding their legality and were further specified during the data collection. For the Google searches it was not possible to set a timeframe.

3.2.2 Skeleton

3.2.2.1 *Nexis Uni*

In Nexis Uni multiple searches were done. The first search was done with a broad timeframe, the year the Olympics took place, to determine the actual timeframe the case took place in, no results were included from this search since it showed the timeframe could be narrowed down to avoid irrelevant data to be included in the results. Furthermore, it was looked into whether overall results were deemed relevant or additional search terms were needed to further scope the search. Further scoping was not deemed necessary. To include non-English sources and additional search was done since Nexis Uni only included English sources within the first searches. To do so, all languages were selected in Nexis Uni except English, Nexis Uni only provides this feature within the category 'News'. This posed no problem since yielded results from the previous searches were also all found in 'News'. Skeleton is an international term that also translates to Skeleton in all other languages found in Nexis Uni and therefore could be used as a search term. A general search in Nexis Uni yielded very general results with many irrelevant data, therefore the search criteria 'headlines' was added. Meaning that the search word had to be included in the headline of the article.

All yielded results from the different searches were scanned for relevance based on the headline and preview provided by Nexis Uni, if necessary the full article was looked into. Table 2 depicts the different searches, their yielded results and the articles included in the final corpus.

Table 2 Nexis Uni searches Skeleton

Search terms	Results	Included	Timeframe	Languages	Other
Skeleton AND Skinsuit OR Skisuits	114	-	01-01-2018 / 31-12-2018	All	Double documents grouped
Skeleton AND Skinsuit OR Skisuits	97	63	12-02-2018 / 17-02-2018	All	Double documents grouped
Skeleton	69	22	12-02-2018 / 17-02-2018	All except all variations of English,	Double documents grouped, in News, Headlines

3.2.2.2 Google

To add to the data collected from Nexis Uni an additional Google search was done. Using the combination of Skeleton and Skinsuit yielded many results but almost all were irrelevant. Probably because of the double meaning of the word skeleton in the English language. Therefore, the term 'Sport' was added. The results were scanned based on the title and the preview provided by Google, after scanning the first 120 results it was not deemed relevant to continue, since the content of the latter results were not related to the case and therefore data saturation was reached.

Eventually, nineteen articles of the 120 scanned results were included in the analysis. The excluded data mainly consisted of overlapping articles with the Nexis Uni search and adverts for consumer skinsuits.

3.2.2.3 Source-based

Based on the initial corpus sources were identified that could provide relevant information on the case. For Skeleton, the website of the International Bobsleigh and Skeleton Federation (ISBF) was scanned for relevant information. This resulted in three data sources containing the international rules for three Skeleton seasons which were added to the corpus. Later the IBSF was contacted to verify the current usage of the skinsuits, the e-mail with their response was also included in the final corpus.

3.2.3 Road Cycling

3.2.3.1 Nexis Uni

In Nexis Uni multiple searches were done. The first search was done in a broad timeframe, the year of the Tour de France up until the year the specific skinsuits were banned to determine the exact timeframe needed. This search showed the timeframe could be narrowed down for following searches to avoid irrelevant data to be included in the results. Additional searches were done using different (combinations of) search terms to include as many relevant results as possible. Many of the retrieved results of these additional searches overlapped with the primary search. Data saturation was eventually reached since additional searches provided little additional data as can be seen in the table below. To also include non-English sources additional

searches were done. As mentioned, Nexis Uni only provides this feature within the category 'News', in this case this also did not pose a problem. To ensure as much languages as possible were included search terms were used that are the same in all languages such as team names. Table 3 depicts the different searches, their yielded results and the articles included in the final corpus.

Table 3 Nexis Uni searches Road Cycling

Searchterms	Results	Included	Timeframe	Languages	Other
Team Sky AND Skinsuit	81	37	01-01-2017 / 31-12-2018	All	Double documents grouped
Team SKY AND advantage AND suit	111	10	02-07-2017 / 31-12-2018	All	Double documents grouped
team SKY AND ban AND suit	59	5	02-07-2017 / 31-12-2018	All	Double documents grouped
Vortex AND Controversy AND Cycling	45	4	02-07-2017 / 31-12-2018	All	Double documents grouped
Vortex suit AND controversy AND Cycling	2	1	02-07-2017 / 31-12-2018	All	Double documents grouped
Team SKY AND illegal AND suit	20	2	02-07-2017 / 31-12-2018	All	Double documents grouped
Team SKY AND illegal	200	1	02-07-2017 / 31-12-2018	All	Double documents grouped
skinsuit AND illegal	26	1	02-07-2017 / 31-12-2018	All	Double documents grouped
SKY AND Vortex	44	40	02-07-2017 / 23-07-2017	All except all variations of English,	Double documents grouped, in News
Team Sky	887	14	02-07-2017 / 23-07-2017	All except all variations of English,	Double documents grouped, in News

3.2.3.2 Google

To add to the data collected from Nexis Uni an additional Google search was done. Using combinations of general search terms such as Team Sky and skinsuit as used in the Nexis Uni search, yielded many irrelevant results. For practical reasons the search was therefore specified to 'Team Sky 2017 Vortex'. Additional searches were done but these did not yield extra results. The results were scanned based on the title and the preview provided by Google, after scanning the first 100 results it was not deemed relevant to continue since the content of the latter results were not related to the case and therefore data saturation was reached. Eventually 22 articles of

the 100 scanned results were included in the analysis. The excluded results mainly consisted of overlapping articles with the Nexis Uni search and adverts for consumer cycling skinsuits.

3.2.3.3 Source based

From the initial corpus other relevant sources were determined and checked for additional data. Archival data from Cycling News and Cycling Weekly, two cycling magazines, was scanned and relevant articles were included, sixteen and four articles respectively. Websites of other cycling magazines were checked but had no archival data available on their website, these organizations were contacted but they had no data available or did not respond. Furthermore, the website of the Union Cycliste International (UCI) was checked for data regarding official statements and regulations, two newsletters containing rule changes were included for analysis.

3.2.4 Swimming

3.2.4.1 Nexis Uni

In Nexis Uni one search was done. This search yielded many results and after a quick scan many of these proved relevant. Therefore the initial search was used. The search term was universal and suitable for all languages so this search also provided results in languages apart from English. Because of the abundance of data, stricter selection criteria for inclusion were used. Articles only briefly reporting the case were left out of the analysis. Furthermore, many of articles were included multiple times in the results despite using the function of Nexis Uni to exclude doubles from the results. Table 4 depicts the different searches, their yielded results and the articles included in the final corpus.

Table 4 Nexis Uni searches Swimming

Searchterms	Results	Included	Timeframe	Languages	Other
LZR Racer	3468	850	01-01-2008 till 31-12-2010	All	Double documents grouped

3.2.4.2 Google

The Google search was done using the same search term as the Nexis Uni search. However yielded results showed great overlap with the Nexis Uni search. Furthermore Nexis Uni provided an abundance of data therefore no extra data from Google was included. Google was used later during analysis to verify some dates relevant for the drafting of the timeline.

3.2.4.3 Source based

While drafting the timeline, the introduction date of a specific swimsuit remained unclear. Therefore one swimsuit manufacturer was e-mailed, who confirmed the introduction date of their swimsuit, this e-mail was added to the corpus.

3.3 CORPUS

This section elaborates on the corpus selected during data collection. Per case the final corpus used for analysis is discussed.

3.3.1 Skeleton

The final corpus for this case consisted of 108 articles including an e-mail from the IBSF. The table below shows the country of origin and the type of articles found per search method. Of the Nexis Uni articles around eighty five percent was from UK sources. The rest of the sources were primarily found in Europe and the United states. Data found on Google was all in English. About ten percent of the articles were opinion pieces on the case. These mostly consisted of articles found in the second step of data collection (Google search). Furthermore about one fifth of the articles were general reporting on the Olympic skeleton races. This part mostly consisted of non-English sources. Roughly seventy percent were articles reporting the controversy. Of which more than half elaborating on the controversy reporting different statements from multiple actors on the case. The rest mainly consisted of general Olympic reporting, briefly mentioning the controversy concerning the skinsuits. The more elaborate articles were mostly from the UK and the reported statements showed much overlap within the different articles published.

3.3.2 Road Cycling

The final corpus of the case consisted of 159 articles. Of the Nexis Uni articles around forty five percent was from UK sources, twenty percent was French. The rest of the sources were primarily found in Europe and the United States. From the data found on Google half was in English, the rest was French or Spanish. About ten percent of the articles were opinion articles on the case. Furthermore, about one third of the articles were general reports of the Tour de France mentioning the controversy. Elaborate case reports reporting statements from multiple actors also made out one third of the total dataset. Fifteen percent consisted of brief case reports and fifteen percent consisted of articles regarding the broader context of the case.

3.3.3 Swimming

The final corpus of this case consisted of 851 articles including the e-mail from the swimsuit manufacturer. About one third of the articles were Australian and a quarter was from the US. The UK, the Netherlands and France individually took up about 10 percent. However, these top countries also accounted for press agencies publishing articles internationally such as Agence France Press (France), Associated Press (US) and AAP Newsfeed (Australia) The rest came mostly from European news sources. Because of the abundance of data no brief case reports were included in the analysis as mentioned in 1.2.4. About seventy five percent of the data consisted of elaborate case reports. Fifteen percent were general reports regarding swimming and the rest were opinion articles or articles covering the broader context of the case.

3.4 DATA ANALYSIS

This section describes the process of analysis for this research. To analyse the data all data was coded using NVivo. The analysis consisted of six consecutive steps. First of all, data was openly coded to ensure all relevant information was taken into account. These codes formed the basis of further analysis. Following, a timeline was drafted to provide a detailed overview of the case and relevant events. To provide more insights in the Strategic Action Fields, relevant actors were defined and evaluation criteria were drafted from the data. To add to this the legitimization of the different technologies was analysed based on three types of legitimacy; Pragmatic, moral and cognitive. Following, the different strategies actors employed were identified. Lastly, all cases were compared based on the preceding analytical steps. These steps are further elaborated on below.

3.4.1 Open coding

To ensure all relevant information was extracted from the data, open coding was used. Data was read through and relevant information was stored in nodes named closely to the wordings used in the data. Because of the data abundance for the LZR Racer, in the case of events or claims, the date and actor were also included in the name of the node to provide a better overview for further analysis. To guide the coding on what was relevant information the concepts of strategic action fields were kept in mind. Meaning information on the field in general, actors in the field, their role, position and actions, the broader field environment was coded. Furthermore, specific events were coded.

3.4.2 Timeline

To draft the timeline, all codes related to events were selected. In addition, nodes containing important claims for the discussion, reporting of the contents of the discussion and official regulations were added to provide an in depth overview. These nodes were then put in a chronological order. To determine this order, the time period discussed in the nodes was looked into, for example sometimes dates or weekdays were mentioned and this was combined with the information on the publication date of the source. Furthermore, for clarification, some dates of specific events were validated using Google.

Additionally, nodes were divided in the three phases defined in strategic action field theory; onset of contention, episode of contention and settlement. The onset of contention is shaped by three key mechanisms as discussed in the theory section. To determine the onset of contention for each case these mechanisms were extracted from the data. Additionally, interaction between an incumbent and challenger is necessary for the onset of contention and was therefore added to the operationalization. All concepts were identified based on the operationalization shown in the Table 5.

Table 5 Operationalization Strategic Action field concepts

Concept	Operationalization
Onset of contention	
Attribution of Threat or opportunity	R&D process of skinsuit
Organizational appropriation	R&D process of skinsuit
Innovative action	Introduction of new skinsuit
Interaction	Opposing actor reports violation of field rules using media or interaction with governance unit.
Episode of contention	All actions and events in between onset of contention and settlement.

Settlement	<ul style="list-style-type: none"> • Governance unit confirming compliance to rules & regulations • Governance unit imposing new rules & regulations • Actors collectively decide on field rules
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3.4.3 Actor roles

To understand how different actors influence the legitimacy of performance-enhancing equipment in elite sport key actors involved in the case were identified from the data. Following, identified actors were categorized based on the concepts of strategic action fields into governance units, dominant actors and challengers. This step does not provide an all-inclusive overview of all actors present in the Strategic Action Field, but does provide an overview of actors involved in the discussion and their position in the field. To further identify which actors introduced or opposed the new skinsuits, the categories opponents and introducers are added since these can be both challengers as dominant actors. Additionally, the identified institutional actors it was defined whether they were a user or producer and what type of user/producer they were. These overlap with the actors categorized in the strategic action field concepts. For example, an actor could be a dominant producer, challenging the status quo. Operationalization is shown in Table 6. Actor roles were assigned based on the moment of competition relevant in the case.

Table 6 Operationalization Actor roles

Actor roles		Operationalization
Governance unit		<ul style="list-style-type: none"> • Widely accepted governing body in the field who is responsible for setting rules and regulations • Local governing bodies • Organizations or governing bodies for specific sport events
Dominant actors	Users	<ul style="list-style-type: none"> • High on official world rankings by governance units • Previous successes in the sport • Reported as being dominant in the field
	Producers	<ul style="list-style-type: none"> • Relatively high budget • Good reputation in the field • Worn by dominant athletes • Reported as being dominant in the field
Challengers		<ul style="list-style-type: none"> • Average to low budgets • Average to low performances in the sport
Introducers		Actors introducing the specific skinsuit.
Opponents		Actors opposing the introduced skinsuit.
Users	Specific user	Actors using the discussed skinsuit or skinsuits with related technologies
	General user	Actors using skinsuits
Producers	Specific producer	Actors producing the specific skinsuit
	General producer	Actors producing skinsuits

3.4.4 Legitimacy

To determine the legitimacy of the use skinsuits two steps were undertaken. First of all, evaluation criteria were identified. These criteria show how performance enhancing equipment is evaluated in each of the fields discussed in the cases. To identify these criteria, nodes focused on evaluation, such as opinions, statements and claims on the technology or other actors were selected. From this selection nodes with similar content were grouped together and concepts

emerging from those groups were defined. To determine the eventual legitimacy of the skinsuits they were linked to the concepts of legitimacy as discussed in the theory section. Table 7 shows the operationalization of these concepts. For each of these three pillars the skinsuits degree of legitimacy was scored based on a five point scale containing negative, neutral and positive values. This scoring was done based on the qualitative results. Scoring did not provide quantitative values used for hard conclusions but are used to make the qualitative results more tangible for comparison.

Table 7 Operationalization Legitimacy

Legitimacy	Operationalization
Pragmatic	Does the innovation work / provides the desired outcome for the user
Moral	Is the innovation desired based on regulatory and normative evaluations
Cognitive	Does the innovation fit with ideas on <ul style="list-style-type: none"> • What the sport should be • How performances should be measured

3.4.5 Institutional change strategies

To understand and analyse the strategic actions of actors to (de-)legitimize the different skinsuits the actions were linked to the five main strategies discussed in the theory section. Data showed some governance unit actions did not fit these strategies, therefore another category was added. Table 8 shows the operationalization used.

Table 8 Operationalization Institutional Strategies

Strategy	Operationalization
Framing	Actors make a claim or statement regarding the meaning of the skinsuit or other actor's actions.
Theorization	Actors make claims regarding the consequences of the skinsuit or actions by other actors.
Collaboration	Actors work together with other institutional actors to pursue their collective interest
Lobbying	Actors call upon governance units to enforce their interests
Negotiation	Actors negotiate with other actors to come to mutual agreements
Governance unit action	Actions by governance units not fitting the other strategies

4 ANALYSIS

This section discussed the results of all the analytical steps taken to answer the research question. First for each case an elaborate timeline discussing the events during the course of the case is provided. Following, an overview of the involved actors and their roles is provided. Then the legitimacy of the skinsuits at the end of the case is discussed followed by the different strategies employed by the different actors to influence this legitimacy. Lastly, the three cases are compared and interesting findings are elaborated on.

4.1 TIMELINE

4.1.1 Skeleton

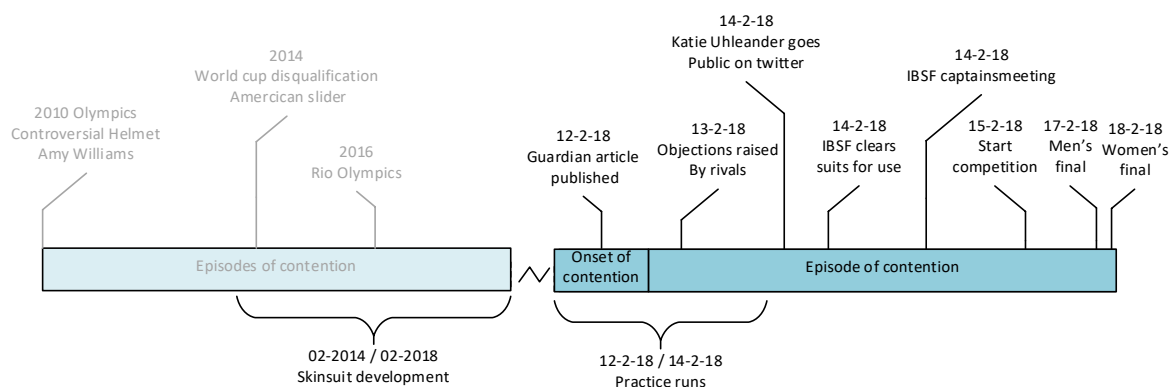


Figure 2 Timeline Skeleton

Figure 2 shows the timeline of events relevant for the controversy regarding the skinsuits of the British sliders in the 2018 Winter Olympics in PyeongChang. The row started when British skeleton athletes performed well during the first practice runs. Rival competitors became sceptic of their impressive training times, mostly because of the men's poor prior performances. British slider Dom Parsons especially drew attention with ranking first during practice runs, despite being ranked twelfth in the International Bobsleigh and Skeleton Federation (IBSF) world ranking. On top of that, the Guardian published an article revealing the British sliders were using high-tech skinsuits with drag-resistant ridges to improve aerodynamics. The article claimed riders wearing the suit could benefit as much as a second per run. These claims together with the impressive practice runs of the Britain's raised concerns amongst rivals and can therefore be seen as the onset of contention. Hence on the second day of training multiple nations questioned the legality of the suits with the skeleton officials. Contention mainly came from the mentioned drag-resistant ridges on the suit, since Skeleton rules state 'no aerodynamic elements whatsoever may be attached either outside or under the race suit'. But the rules do not get more specific than that providing a grey area. For example, the rules do not specify how the suits are stitched together or how different materials can be used.

10.16.3 Clothing Training and race suits with short pants and short sleeves are not allowed. No aerodynamic elements whatsoever may be attached either outside or under the race suit. If the Race suit has a hood attached, this must be worn completely or removed completely from the suit. The hood of the suit is not permitted to be tucked in, rolled, sewed into place or otherwise used in a fashion other than its intended purpose; to cover the athlete's head. Race suits must be manufactured from an uncoated textile. – International Bobsleigh & Skeleton Federation (2017)

The suits in question were developed by the English institute of Sport together with TotalSim, known from working with the British track cycling team for the Summer Olympics. Consequently, the suits are said to be a continuation of the technology from the suits the British cycling team wore in the 2016 Olympics in Rio. However also in skeleton the suits were not completely new, British sliders Amy Williams and Lizzy Yarnold already won Olympic gold in predecessors of the suit in the 2010 and 2014 winter Olympics. But in the four years leading up to the Winter Olympics in PyeongChang the British Skeleton team benefited from a £ 6,5 million Lottery funding. It is expected a considerable portion of this budget was put in the development of the skinsuits. For the development and the fitting of the skinsuits, 3D models using a laser scan were made of the athletes to test how aerodynamics flow around the body to help with seam and material placement, and to ensure a perfect fit. But the skinsuit was not the only innovation for this Olympics, British slider Dom Parsons said it was part of a package of innovations including for example, a specifically designed sled and runners for the PyeongChang track. Parsons also mentioned bits and pieces of the innovations get used throughout the season mostly on sled set-up and design but a lot gets held back till the Olympics, like the suits.

We don't get hold of the technical innovations until the Olympics and as soon as we finish competing it all disappears into someone's bag and is taken away," - Lizzy Yarnolds (Ingle, 2018a).

The discussion over the legality of the skinsuits further intensified when after the last day of practice Katie Uhlaenders, an American slider, publicly questioned their legality on Twitter. After which the IBSF stated the suits were checked and cleared for competition. The British Olympic Association also issued a statement insisting their suits were compliant. That same evening the issue was brought up at a meeting hosted by the IBSF for all team captains scheduled regardless of the controversy. Here Great Britain stated the suits were fully compliant and a Team GB source claimed no further objections or questions had been raised. However, the discussions kept going with Katie Uhlaenders wondering if she could use similar suits and questioned the suits regarding to a level playing field. Media also reportedly expected the debate to rise again if Britain would prove to be successful in competition. On the final day of the men's competition Dom Parsons took bronze and a day later in the women's competition Britain's Lizzy Yarnold and Laura Deas took gold and bronze respectively.

No official complaints were reported based on the final rankings. However, some people still felt the suits were not legitimate. For example, the Latvian coach criticized the use of technology by the British and claimed that made the difference for them in the end, he also stated the IBSF was weak for not ruling in this case. Journalists of the Guardian and the Herald took the discussion more broadly and questioned where the line should be drawn for technology in sports or whether the £6,5 million funding British Skeleton enjoyed was justifiable. However, the discussion quickly bleed out after the Skeleton event and no clear settlement could be distinguished. Furthermore, rules on equipment and clothing has not been changed or tightened by the IBSF since.

4.1.2 Road Cycling

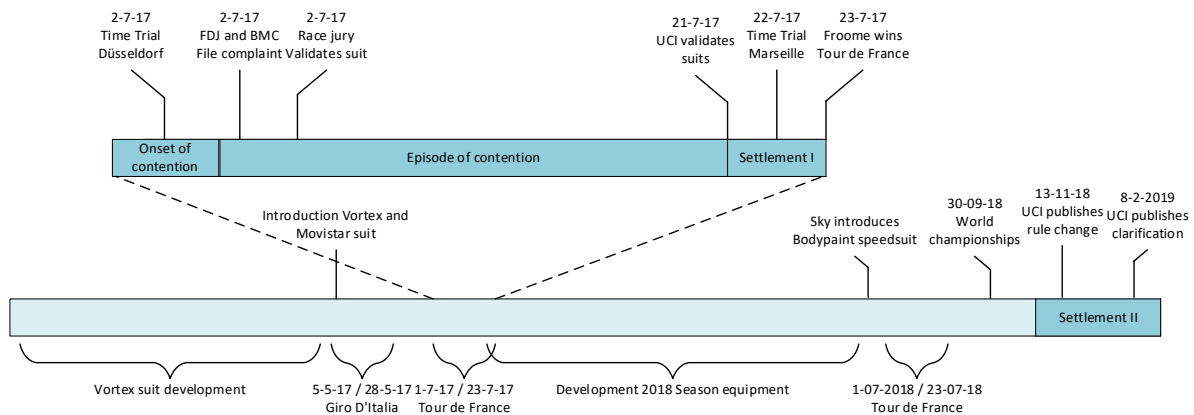


Figure 3 Timeline Road Cycling

Figure 3 shows the timeline of events relevant for the controversy regarding the Vortex skinsuit worn by Team Sky in the 2017 Tour de France.

Team SKY had dominated the Tour de France for several years, had a reputation for innovation and introduced the strategy of marginal gains in cycling, now used by all top teams. On top of that they have by far the highest budget with thirty five million euros over for example, twenty and fourteen and a half million of Astana and Ag2r respectively. This budget does not only allow signing the best riders but also 3D body scans for custom fitting of the suits and testing it for many expensive hours in the wind tunnel. Following, the Vortex suit was developed by Castelli who partnered up with team Sky at the start of the 2017 season. Steve Smith, Castelli's brand manager, stated the skinsuits were way more revolutionary than they looked and they had to reinvent everything they knew about skinsuits. The suits were introduced midseason and were already used at the Giro D'Italia. Furthermore, with Dave Brailsford, former performance director of the UK cycling team, Team Sky can benefit from the work done for the London Olympic games. However, Brailsford involvement also had its downsides. The team had been dodged with scandals in the lead up to the Tour, specially the suspicions over the use of Therapeutic Use Exemptions of Bradley Wiggins before his three biggest races all under the watch of Brailsford. During the Tour team Sky remained under suspicion and their transparency and ethics were constantly questioned.

The Tour de France kicked off with a Time Trial in Düsseldorf. Innovation is seen as essential in Time Trials to gain seconds over competitors, therefore most riders show up in special skinsuits but also their bikes, wheels and helmets are specifically designed for Time Trials. Four riders of Team Sky finished in the top eight with Geraint Thomas finishing first and Tour favourite Chris Froome finishing sixth. Specially for the Tour Team Sky wore white jerseys. The white colour in combination with the light rain that fell during the race showed bands with little air bubbles in the jerseys of Team Sky. This in combination with their successful runs raised suspicion under

competitors since official Union Cycliste Internationale (UCI) regulations prohibit any additions to jerseys, especially anything that improves aerodynamics.

“It is forbidden to wear non-essential items of clothing or items designed to influence the performances of a rider such as reducing air resistance or modifying the body of the rider (compression, stretching, support). Items of clothing or equipment may be considered essential where weather conditions make them appropriate for the safety or the health of the rider. In this case, the nature and texture of the clothing or equipment must be clearly and solely justified by the need to protect the rider from bad weather conditions. Discretion in this respect is left to the race commissaires... Garments must not be adapted in any way such that they diverge from their use purely as clothing. The addition of any non-essential element or device to clothing is prohibited...It is also prohibited to wear clothing or skinsuits to which nonessential elements have been added with a view to improving their aerodynamic properties such as, for example, “wings” under the arms or an extension between the helmet and the jersey or skinsuit. It is obligatory for clothing to follow the cyclist’s body shape.” (Squire Patton Boggs (US) LLP, 2017)

After the race two rival teams, FDJ and BMC complaint to the race commissaires of the Tour that Team Sky wore jerseys with technology that improves aerodynamics and are therefore illegal. They also went public with their concerns. Fred Grappe, performance director of FDJ claimed a study showed the so called Vortices on the suits the Vortex bands reduce the coefficient of penetration in the air by five to seven percent, resulting in a power gain between 24 and 33 watts. For the Düsseldorf Time Trial this would mean a 18 to 25 second advantage. Despite these claims Philippe Marien, head of the race jury, validated the suits saying the dimples were integrated not added, and therefore he had no legal certainty to prohibit them. He added the commissaires had no authority to further judge the matter and passed the ball to the UCI. He expected the UCI to rule before the next and final Time Trial of the Tour but he did validate the classification of this first Time Trial.

Team SKY denied breaking the rules and claimed everything was checked by race officials. In regard to the regulations Nicholas Portal, Team Sky’s sports director stated they were not breaking the rules since the vortexes were integrated in the suit, not added to it. He also claimed other teams made use of similar materials but where not under attack. Additionally, team manager Sir Dave Brailsford, stated that they have already been using these suits in previous major races this season and everything was checked and cleared. He accused other teams of failing to do their job only noticing the suits now and not in previous races.

José Luis Arrieta, director of Movistar, claimed they already used these type of suits from Endura for a long time. It is unclear for how long exactly but the suits were already worn at the Giro, just as Team Sky’s. However, this was not picked up on by others and the debate continuously focused on Team Sky. FDJ an BMC continued the debate while other teams stayed out of the discussion. FDJ and BMC stated Sky abused vague wording in the regulations and questioned Sky’s interpretation. The complexity of the rules already exist with every Time Trial where bikes that get passed at one event gets rejected at another. In this case the discussion mostly focused on whether the Vortex was seen as an addition or integral part of the jersey. Grappe insisted the commissaires to rule otherwise we would see all kind of skinsuits that modify the shape of the body at the Marseille Time Trial.

Media closely followed the debate and most adopted the claims made by Grappe regarding the 18 to 25 second advantage. Bert Blocken, professor of aerodynamics at the University of Eindhoven (The Netherlands) also backed the claims made by Grappe. Others were more critical of this. The study cited by Grappe focused on marathon runners with vortexes added at more places than just the arms and shoulders. Furthermore, researches from Fluid Dynamics, UK

Sports engineering and Bioracer (Skinsuit manufacturer) stated these time gains were unrealistic.

On the eve of the final Time Trial in Marseille a UCI spokesperson confirmed the Vortex suits and others such as Movistar's suit were compliant. He added the suits have been used in other races this season and have been checked by the UCI commissaires. Team Sky thereby confirmed their athletes would be wearing the Vortex suit again for the Marseille Time Trial. However, Froome could not wear the special suit. Because he was first in the overall classification he was obliged to wear the yellow jersey provided by the organization. He quickly ended worries of him not being able to wear the Vortex suit.

"It's a huge honor to be in the yellow jersey at this point. I've ridden in the skinsuit provided by the race organizers almost every year since I've won the Tour and it hasn't been a problem. At the end of the day it's all about the legs. Certainly at this point, it's my race to lose". – Chris Froome (The Press Association, 2017)

He proved his point by finishing third thereby claiming his fourth victory of the Tour de France.

The public debate surrounding the issue halted after the Tour de France. In December 2017 the new UCI president, Lappartient claimed his main objective was to put mechanical doping to an end, mostly referring to the use of motorized bikes. For the following 2018 season no rule changes were made. Allowing innovation in skinsuit aerodynamics to continue. Endura released their 'most aerodynamic kit yet' improving aerodynamics using silicon chevrons on the shoulders, arms, sides and thighs. Sky continued their collaboration with Castelli and introduced the bodypaint speedsuit to replace the Vortex for the 2018 Tour de France. This suit was skintight and did not make use of aerodynamic additions. Steve Smith, Castelli's brand manager stated this was not to avoid controversy. They were already working on the suit during the 2017 Tour de France. This suit was specially made for the upcoming time trials but would have been less favourable for the time trial in Düsseldorf. If the riders would ride the Düsseldorf time trial the Vortex would have been faster. For the 2018 world championships, Bioracer introduced a new speedsuit making use of speedsilk and other aerodynamic additions which proved effective at the championships.

During the 2018 Tour it was reported that the new UCI equipment manager Péraud intended to clarify UCI regulations by the end of the season to avoid teams and brands taking advantage of possible different interpretations. On 13-11-2018 the UCI published a newsletter including the announcement rules on clothing were changed relating to the purpose and limitations of clothing. Specifically focused on aerodynamic properties in response to the development of clothing technologies which became effective from 04-03-2019 onwards. At 08-02-2019 they added a clarification to prohibit the application of any substance to the garment or skin to improve aerodynamic performance. These rule changes made the Vortex and the Endura Drag2Zero non-compliant. The new bioracer speedsuit using speedsilk did comply with update regulations. Castelli's brand manager stated they were happy with the new regulations and confirmed they already had a new and faster suit for the 2019 season.

4.1.3 Swimming

Figure 4 shows the overall timeline of events leading up to the controversy regarding the LZR Racer swimsuit developed by Speedo for the Beijing 2008 Summer Olympics leading to the eventual ban of full body swimsuits from 2010 onwards. More detailed timelines are depicted in figure 5 to 9 and can be found throughout the elaboration on the overall timeline to provide a more in depth view.

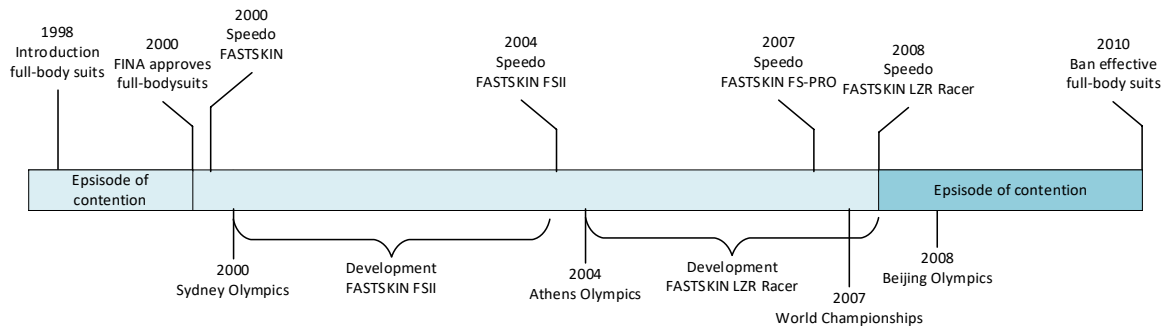


Figure 4 Timeline Swimming

Speedo unveiled the FASTSKIN LZR Racer on February 12th 2008 at four events in New York, Sidney, London and Tokyo simultaneously. The suit was hailed as ‘world’s fastest swimsuit’ and modelled by some of swimming’s best. Michael Phelps (US) claimed he felt like a rocket when diving into the water, Grant Hackett (Australia) described it as a hot knife going through butter and Ryan Lochte (US) said he felt like a superhero in the suit. The LZR Racer was welded together to create a seamless piece with polyurethane panels at strategic parts of the body resulting in 10 percent less passive drag than Speedo's FASTSKIN FSII launched in 2004 and 5 percent less passive drag than Speedo's FASTSKIN FS-PRO, which was launched in March 2007 and has seen swimmers break 21 World Records as a result.

Speedo’s Aqualab spent over three years developing the suit, reportedly costing between 3 and 10 millions of dollars. Speedo used a team of experts from NASA, Nottingham University, the University of Otago, the Australian Institute of Sport, ANSYS a company specialized in computational fluid dynamics software and the input of many top athletes. They also made sure every step of the process was approved by the Fédération Internationale de Natation (FINA), swimming’s governing body. The final product was protected by sixteen patents.

The first full-body swimsuits were introduced in 1998. Back then there were already concerns regarding the buoyancy, a principal banned by FINA. FINA gave them the green light before the 2000 Sydney Olympics. Most swimmers here wore a suit that at least covered half of their body. At the Sydney Olympics, 83 percent of medals won were in the Speedo FASTSKIN, a precursor of the LZR Racer. Four years later Speedo introduced the FASTSKIN FSII but this was not as successful as it’s precursor. Bruce Mason from Speedo said the suit was fine but it just wasn’t a leap forward so Speedo made it it’s mission to be back on top the next Olympic year. It’s common for manufacturers to introduce suits shortly before the Olympics, working in Olympic cycles for innovation. Speedo competitors Adidas and Nike, who are also involved in other Olympic sports, admitted they employ more than thirty full-time designers and scientists, many of whom spend each four year Olympic cycle working on an individual shoe or fabric. Speedo did deviate from this cycle by introducing the FASTSKIN FS-PRO in 2007 for the World Championships in Melbourne. This interim version of the LZR Racer broke 21 World Records in the first year. Jason

Rance, head of marketing of Speedo, mentioned people thought this already was their suit for Beijing but they wanted to keep the real thing (the LZR Racer) a surprise.

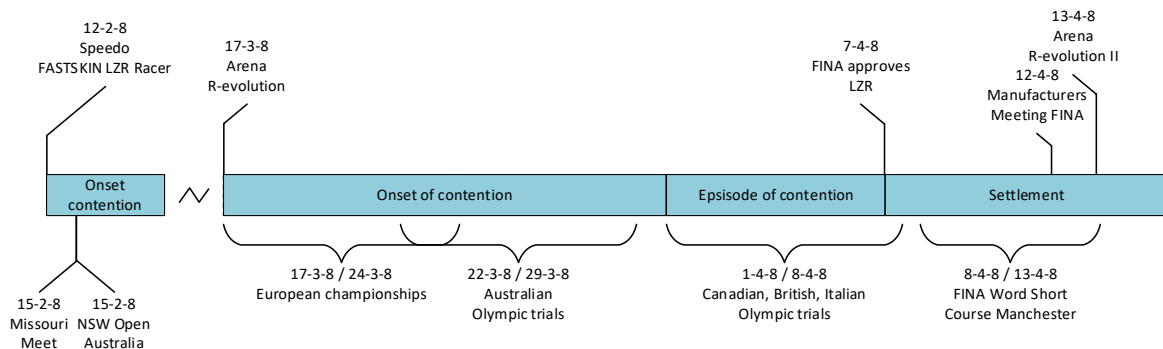


Figure 5 Detailed Timeline Swimming part 1

The first weekend after the introduction of the LZR Racer three World Records were broken by athletes wearing the suit at a Missouri meet and the Australian championships. In the following week, during the European championships in Eindhoven were held and the total of world records broken in the LZR rose to eleven. French sprinter Alain Bernard broke the 100m freestyle world record twice in two days causing the French technical director Claude Fauquet to question the new suit and calling for a debate. He claimed an ethical debate was necessary since possible consequences of the suits for the future of swimming were unknown. Alain Bernard is privately sponsored by Speedo but the French federation is sponsored by Speedo's competitor Arena. The day before the European championships Arena unveiled their Powerskin R-Evolution suit. The company claims that its suit provides a 54-hundredths of a second advantage in a 50-meter race over its previous outfit, reduces drag by 20 percent, allows a swimmer to maintain top speed for 24 percent longer, is even lighter than the LZR Racer, is made from one piece of fabric, has no seams on the front and is fully stitchless. But the suit did not enjoy the same success as the LZR Racer

The success not only led Fauquet to question the LZR Racer, other concerns were reported about the buoyancy of the suits, a feature marketed by Speedo but a principle banned by FINA.

"No swimmer shall be permitted to use or wear any device that may aid his speed, buoyancy or endurance during a competition." - FINA Handbook of 2005-2009 (Swanton, 2008)

FINA claimed the suits were checked and legal but that they would meet with the manufacturers at the world short course in April to ask some questions about the thickness of the material of the suit, adding that issues with buoyancy needed to be sorted out. The material of the suit also posed a problem for Arena since rules stipulate suits should be comprised of 'regular flat fabrics' and should be 'the usual thickness' without further specification. FINA also stated that the number one priority is that all suits are available to everyone at the time of the launch. At the Australian Olympic trials another eight World Records were set.

Because of the assault on the Record Books, head coach of swimming Canada, Lafontaine called for a halt on new swimsuit technology. He stated that technology was good for the sport but that the FINA should ensure fair introduction of new technologies. Later the Canadian swimming federation stated the LZR Racer would not be allowed during the Canadian Olympic trials because it could not be made available to all competitors in time. FINA regulations state

equipment should not be admitted at competition if it is not available to all participants. Italy followed Canada and also decided not to allow the new suit at their championships also because of the suits not being available to all.

On the 7th of April FINA brought out a statement claiming the legality of the LZR Racer. However, it also became clear FINA had no real test to determine buoyancy and it was agreed upon that the manufacturers would propose new methods of testing and additional criteria for approval. Arena asked for a ban on all suits till further testing could give more clarity on possible performance enhancement of the new suits. To attract attention they used a full paged advert in a newspaper to call for the ban. FINA already scheduled a meeting on the 8th of April with all suit manufacturers to discuss the approval procedures and regulations for swimwear before the introduction of the LZR Racer, but this suit was now high on the agenda. During this meeting Arena was alone in their call for an halt. After the meeting FINA released a statement that all swimsuits were compliant.

"FINA is always willing to examine issues in connection with the swimsuit approval. However, to the best of our knowledge, there is no objective scientific evidence on the alleged buoyancy advantage provided by the Speedo LZR Racer or any other swimsuit approved by FINA. We underline that at FINA competitions, the rule GR 5.6 - 'the manufacturers must ensure that the approved new swimsuit will be available for all competitors' - will apply." – FINA (Agence France Presse, 2008)

In regard to the regulations stating no device should aid buoyancy they explained swimmers were not using a device but simply wore a suit. Furthermore, they admitted that the wording regarding the use of materials were not clearly formulated. They explained there was now a broad understanding that the word fabric in the regulations was not restricting to only using textile fabrics but other materials could also be used, such as polyurethane, as had always been the case. Adidas, for example, already got approval for using this material before Speedo. Arena responded they had a different interpretation of the word fabric and that they already had prototypes going in that direction that they would now file for approval. A day later they unveiled a prototype but since it was not approved yet by FINA it could not be worn in the finals of the ongoing World Short Course in Manchester. During these championships a total of 18 world records fell.

Despite FINA's approval contenders still viewed the LZR Racer as unfair. Mark Schubert, head coach of US swimming said other manufacturers needed to put in the same effort as Speedo, catch up and quit whining. One competitor said that if they wanted to catch up they had to make a suit that broke the rules since the Speedo suit was protected by a lot of patents. Alberto Castagnetti, head coach of Italy said about the decision;

"This is going down a very dangerous road, It removes the purely competitive aspect of the sport and puts outside factors into play. Swimming has always been based on ability. Now, there are other aspects. It's like technological doping. It's not in the spirit of the sport." - Alberto Castagnetti (Dampf, 2008a)

The term 'technological doping' got picked up by media and has been reported as the voice against the new developments throughout the discussion. Other contenders also regretted that the suits became the focus of swimming instead of the athletes and said the costs of the suit and sponsor deals caused a have and have not situation in the sport. Swimming was always seen as a pure sport and the suits changed this turning swimming into formula one like some say.

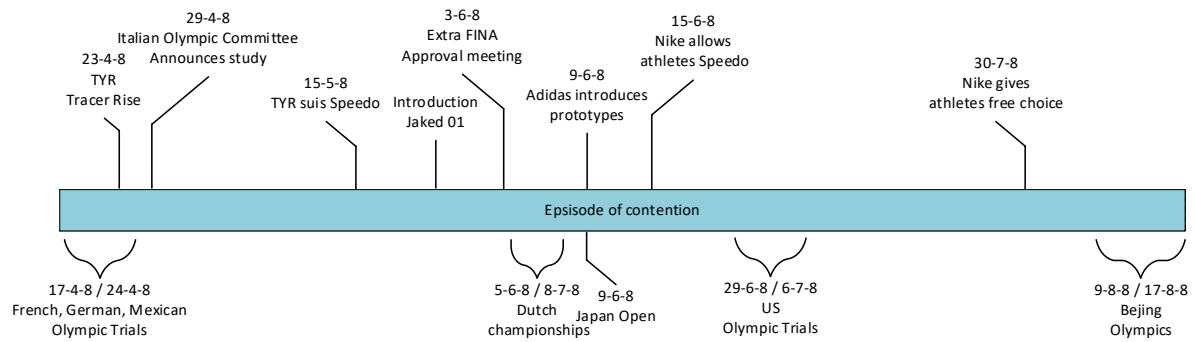


Figure 6 Detailed Timeline Swimming part 2

Following FINA’s decision to allow the LZR Racer both the French and Germans felt they could not ban the suits for their Olympic trials. With Claud Fauquet stating it was legally impossible to ban the suit but that he regretted the inequalities caused by the manufacturers inability to deliver equipment to all athletes. The Mexican swimming federation did decide to not allow the new suits in their qualifications because not all athletes could afford them. During the French qualifications TYR unveiled their Tracer Rice swimsuit, also made of polyurethane claiming a four percent increase in performance against the two percent claimed by Speedo. Despite the introduction after Speedo, TYR already had athletes trying the suit in competitions in January.

To get to the bottom of the supposed performance enhancement of the LZR racer the Italian Olympic Committee asked the Italian institute of medicine and science to conduct an in depth study on the impact of the suits. TYR also felt disadvantaged and filed a lawsuit against Speedo not against the suit itself but for distortion of competition. The lawsuit mainly focused on Mark Schubert, head coach of US swimming and sponsored spokesman for Speedo. TYR felt his double role posed a conflict of interest. Schubert strongly advised all US athletes to wear the Speedo LZR Racer if they wanted a shot at making the Olympic team and saying they had to choose between sponsor money or a gold medal. Schubert claimed he made those statements not because of his sponsor deal with Speedo but because he truly believed the LZR was the best suit. TYR also included US athlete Erik Vendt in the lawsuit for swimming in a LZR Racer instead of a TYR suit, breaching his contract. Steve Furniss, TYR co-founder was also critical of manufacturers that made claims that were not tested, pointing to academic papers stating TYR suits were the more buoyant than the LZR Racer and therefore performed better. Despite these studies TYR still struggled to convince athletes to swim in their suits.

Because of the approval of the LZR Racer and pressured by their sponsored athletes, Speedo rivals rushed to come up with their own supersuits in time for the Olympics. On the 3rd of July, FINA hosted an extra approval meeting to approve new suits for the Beijing Olympics. FINA approved new suits from Arena, Adidas and Mizuno, a Japanese manufacturer. The Jaked 01 suit from new Italian manufacturer Jaked was also approved but this was not widely reported at that time so the exact date of introduction is unknown.

Despite upgraded suits many athletes and countries dropped their sponsors to be able to swim in the LZR Racer, risking heavy fines and missing out on valuable sponsor money. Japan for example, usually raced in suits from domestic manufacturers. Following the record rain of the LZR Racer, Japan gave three domestic suppliers the chance to upgrade their suits but Japanese athletes still preferred the LZR Racer making the Japanese federation allow their swimmers free choice of suits. Italy also caved and cancelled their contract with Arena providing athletes the wear a suit of their choice. Two days later Italy signed a contract with Jaked but this did not bind

the Italians to wear a Jaked 01 suit. Germany was not ready to give up their sponsor money and stayed with Adidas to the dissatisfaction of their athletes. German star Thomas Rupprath commented 'I feel it is a disadvantage if I am not allowed to wear the suit in which I feel most comfortable. After all, Michael Schumacher didn't suddenly have to start in an Opel after all the tests in the Ferrari'. He also stated you would have no chance internationally if you would not swim in the LZR Racer.

Shortly before the US Olympic trials starting on July 30 Nike decided to let their sponsored athletes wear the Speedo LZR Racer without any consequence. A Nikes spokesperson said this was a onetime exception to let the athletes experiment with other suit and compete without distractions. At the trials another six World Records were broken, all in the LZR Racer. A month later, just a week before the Olympics Nike announced they would let their athletes wear other suits, stating they would not want to prevent the athletes to perform their best at the Olympics.

Because many athletes were provided the opportunity to wear the LZR Racer, Speedo struggled to keep up with demand. A South African Speedo representative claimed they did not have to deliver to teams from other sponsors and said their sponsored teams would be preferenced in supplying. However, Speedo international commented it was optimistic in that they could provide all swimmers with an LZR Racer at the Olympics and they would follow FINA's guideline that suits must be available to all athletes.

On the 8th of August the Olympic games started. To ensure a level playing field FINA let representatives from the leading brands set up rooms at the pool to supply athletes with their suits. Speedo supplied 3000 free suits to the Olympics making sure every athlete could wear their LZR Racer. During the Olympics a total of 25 World Records fell. Speedo swimmers were responsible for 23 of the 25 world records. Speedo also accounted for 94 percent of gold medals and 89 percent of all swimming medals won during these Olympics.

However, still many people felt the suits were not the only cause of the record rain since February. Multiple reasons for the records were given by multiple stakeholders. Australian athletes and coaches lead by Alan Thompson claimed the impact of the suits was negligible. He stated that increasing professionalism and improved training techniques also greatly impacted performances. US coaches and athletes stated the suits made a little difference but the records could not only be attributed to just the suits, it mostly came down to the hard work of the athletes. Even though both athletes and coaches fiercely promoted the impact of the suits before the Olympics. Both Australia and the US also felt that the records would be broken anyway since athletes are always at the best of their performance during an Olympic year. Other innovations such as the design of the Beijing pool were also pointed to as possible contributors. The mental aspect was also touched upon, if you think you have the fastest suit, you will probably swim faster. Others mentioned it was just a big PR stunt and Speedo simply had the best swimmers under contract.

Others however, did not doubt the suits were responsible for all the records. Dutch head coach Jacco Verhaeren, Thomas Jansson head coach of the Swedish Olympic team and Canadian head coach Lafontaine stated the suits definitely contributed greatly to the records. Jacco Verhaeren was a contender of the LZR racer from the beginning, calling for better regulations and a level playing field. And although some people were unconvinced the suits were responsible for the records the Olympic games were a turning point. Italian swimmer Magnini reportedly spoke to many athletes all in favour of going back to swimming trunks.

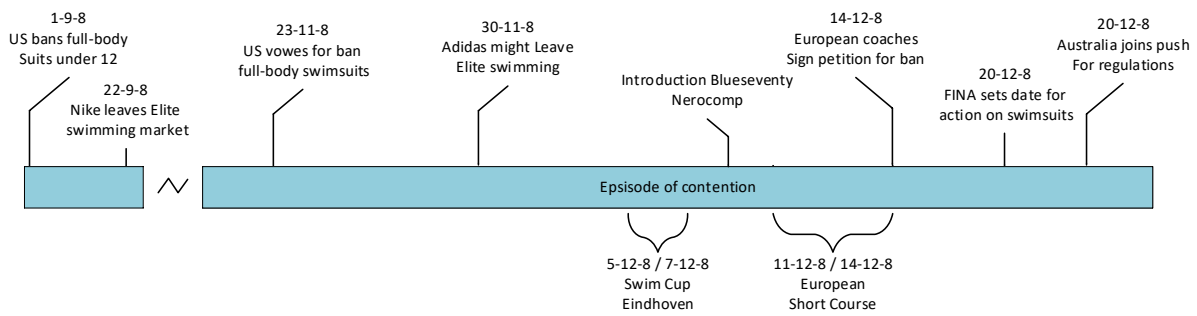


Figure 7 Detailed Timeline Swimming part 3

A month after the Olympics the US decided to ban all new generation swimsuits in junior competition under twelve years. In that same month Nike announced they would leave the elite swimming business claiming elite swimming did not fit with their long term growth plan. Nike denied it had anything to do with Speedo's success at the Olympics. Evan Morgenstein, an agent representing many top-swimmers stated this was a blow to US elite swimming since swimmers are highly dependent on sponsors, especially in non-Olympic years. Morgentstein stated other apparel companies in the US apart from Speedo and their did not fund athletes and Nike leaving could be a precursor for other funding trouble for the US swimmers. At the end of November, Adidas declared they might follow Nike if the sport did not introduce fair and professional rules and approval processes regarding the swimsuits.

A week before Adidas' announcement, the US vowed to ban full bodysuits. They sent a proposal to FINA asking for more regulations on swimsuits. First of all, they proposed to change the current rule stating 'no swimmer shall be permitted to use or wear any device that may aid his speed, buoyancy or endurance' by adding the words 'or swimsuit' because FINA states that swimsuits are not a device. Furthermore, they called for suits to be tested by 'an independent agency (that) will utilize established globally recognized procedures to determine compliance'. Executive director of the American Swimming Coaches Association, John Leonard wrote 'This is a battle for the soul of our sport. Shall it continue to be about hard work, attention to detail and athleticism, or shall it deteriorate into a soulless contest of engineering expertise?'. US swimming handed in another proposal for further sharpening of the rules, they ask that 'the competitor must wear only one swimsuit in one or two pieces which shall not cover the neck, extend past the shoulder, nor past the knee.' It is also calling for approved suits to be 'available for all competitors for 12 months prior to the Olympic Games'. US Speedo representative stated that this would not necessarily impact the LZR Racer, only a few versions would not comply to these guidelines, furthermore he stated the lengths of the suits were part of a much broader technical debate FINA should consider.

In the build up to the European Short Course on the 15th of December a group of European coaches asked for a ban on the Nerocomp suit from Blueseventy out of fear for unfair competition. Blueseventy was known for their triathlon wetsuits but now also introduced a suit for indoor swimming, it is unclear when this suit was exactly introduced. The coaches stated that the suit impacted performance too much being basically a wetsuit that changes the body position and significantly increases buoyancy because of the Neoprene material. Following the US proposal and the critique of the European coaches FINA requested new research on the high-tech suits on the 12th of December. FINA executive director Cornel Marculescu said 'We have to be sure we are doing the best thing possible for the sport, together with the manufacturers'. FINA would look at the thickness of the new suits and seek for a scientific test that will determine

whether the suits are 'credible'. FINA claimed they were in contact with a very important university that would perform the research and they expected information to be available at the beginning of 2009. Meaning there would be no changes before the outcomes were known.

At the Swim Cup in Eindhoven in the beginning of December, Jacco Verhaeren stated there would be mandatory suit checks. During this Swim Cup, Dutch swimmers could qualify for the coming 2009 World Cup in Rome. But Verhaeren explained that due to the possibility that the suits worn by athletes could make a difference in swimming times, the qualification could be unfair. Therefore, the suit brand was noted and pictures were taken of the outfits worn. If in the following months it would become clear certain suits were clearly faster, qualifying times could be corrected ensuring the best swimmers would qualify for the World Cup.

Later that month the European Short Course was hosted. This Short Course, again many records fell, especially the relatively unknown suit from manufacturer Jaked performed well, collecting 17 medals in total. Some athletes, like the German Rupprath protested the suits by swimming in old-fashioned trunks. Other swimmers however, wore multiple suits to increase their buoyancy, something that reportedly was already done at the Beijing Olympics by some. At the end of the tournament most athletes and coaches were fed up with the suit discussions. Jacco Verhaeren, in consultation with his Australian and US colleagues drafted a petition to regulate swimsuit technology. The petition was eventually signed by 15 out of the 17 competing countries. The contents were similar to the demands of the US, prohibition of wearing multiple suits, control for thickness and materials and ensured availability 9 to 12 months in advance of major competitions.

Five days later Australia also officially joined the push to regulate high tech swimsuits. Australian swimming banned the suits for junior competition based on the limited availability and high costs of the suits. Furthermore, Thompson who was a partisan at first, discussed that the situation got out of hand and regulations were necessary. He claimed FINA did not have the regulations in place to stop people from having an unfair advantage. He also stated that especially wearing multiple suits was against the spirit of the sport. Australian swimmers also backed this opinion. Thompson and Hackett (Australian Olympic) did however claim to not have a problem with the LZR racer saying it was legal and did not provide an unfair advantage, problems laid mostly with the suits following the LZR Racer. Jacco Verhaeren backed this, claiming the LZR Racer was a difficult case since it did not provide that much buoyancy, the suits that came after he found much worse.

At the end of 2008 a total of 108 world records fell, for men the average longevity of a record fell from 680 to 382 days and for women from 921 to 247 days. Critique was not directed at athletes wearing the high-tech suits or the suit manufacturers, but at FINA. Many felt they were responsible for letting it come this far. They should have made clear rules at the introduction of the LZR Racer or maybe already when full body swimsuits were introduced. Banning and then approving suits two weeks later was just an example of inconsistent management of FINA. It led to people completely losing trust in FINA and their handling of the issue. Many also blamed FINA's eagerness for World Records and their sponsorship deal with Speedo for the improper testing of the LZR Racer. Due to all the critique FINA made an announcement they set a date to 'take appropriate action' regarding the swimsuit debate at their conference in Dubai in March.

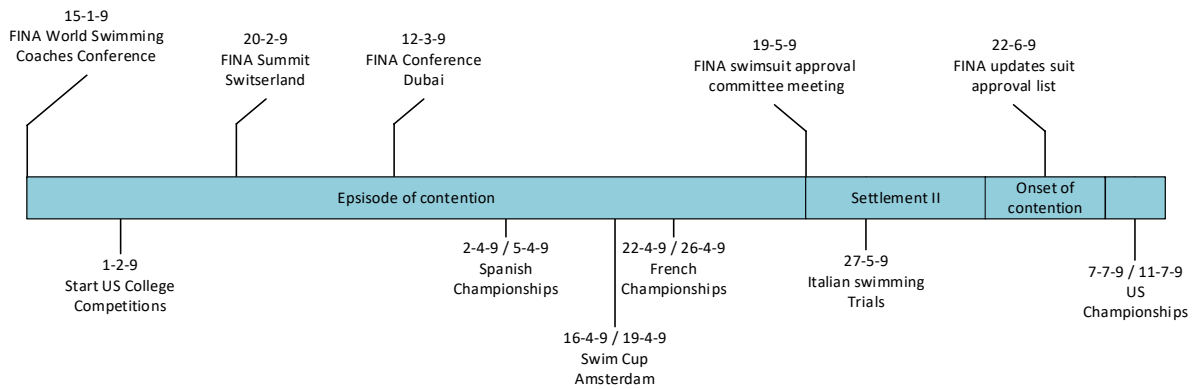


Figure 8 Detailed Timeline swimming part 4

At the 15th of January FINA hosted the world swimming coaches conference, here the focus was not on the swimsuit issue but more on training and education. However, FINA did keep coaches updated on the process with FINA executive director Cornel Marculescu saying some changes were probably going to be made. He also stated that they needed to ensure swimmer's ability, and not his choice of equipment, counts for more when it comes to winning and losing in the pool.

In February college swimming competitions started in the US and many coaches regretted that the high-tech swimsuits were legal. They stated it was a shame that the focus was on the suits and not the athletes. Some students even cut their budget on busses and hotel rooms to be able to afford the LZR racer. But everyone agreed that it was not possible to compete for the top places without wearing a high-tech suit.

On the 20th of February, FINA hosted a summit bringing together representatives of swimmers, coaches, lawyers and suit manufacturers to discuss new regulations. Manufacturers already met the night before, deciding they wanted to present a united front to the FINA asking for more clear-cut rules but still allowing swimsuit innovation to continue. The summit led to proposed amendments which would be discussed at FINA's meeting in Dubai march 12 to 14. The proposal aimed to limit the suits ability to provide an unfair advantage as announced during the coaches conference earlier that year. Suits should end below the neck and before the shoulders and ankles. Furthermore, thickness should not exceed 1 millimetre, cannot be customized for individual athletes and electrostimulation or pain reduction through swimsuits would be banned. These rules would be applicable till the end of 2009 when stricter rules would be imposed for 2010.

During the FINA conference in Dubai FINA decided on the final measures for the 2009 season. Previously proposed measures from the FINA summit were effective immediately till December 31st, 2009. Additionally, swimsuits could weigh a maximum of 100 grams limiting buoyancy. Furthermore, the wearing of multiple suits was banned. Manufacturers must submit suits by march 31 for testing. FINA set up an independent test and control program responsible for testing all swimsuits for buoyancy and thickness. FINA did not comment on what would happen with records swam with the high-tech suits. For 2010 even stricter regulations would be imposed,

possibly also limiting the use of non-permeable materials such as polyurethane. About the new measures FINA said:

“FINA reaffirms that it will continue monitoring the evolution of the sport equipment with the main objective of keeping the integrity of the sport, FINA wishes to recall that the main and core principle is that swimming is a sport essentially based on the physical performance of the athlete.” – FINA (The Associated Press, 2009)

Jason Rance, from Speedo, was confident the LZR Racer would pass new tests for buoyancy saying they always tested their suits for buoyancy since they did believe it's fair for suits to help you float in the water. He also expected the LZR Racer to survive the introduction of stricter rules for non-permeable materials since the LZR Racer is not fully made of non-permeable materials like some of its competitors. Furthermore, Rance stated that Speedo would still be able to produce a superior suit even with stricter regulations saying; 'It gets harder in some ways but then technology moves on.'

At the beginning of April, Spanish championships were held where the Jaked 01 suit again made headlines. Later that month at the swim cup in Amsterdam there were also discussions surrounding the Jaked 01. The Dutch spokesperson from Speedo said Dutch swimmers were not allowed to wear the Jaked 01 suit according to their contract with Speedo. The director of the Dutch swimming association however claimed they had the same clause as the US and Australia and had a free choice of suits. During the swim cup one athlete asked for an extra time trial where he wore the Jaked 01 suit instead of a Speedo LZR Racer to show that objective selections are not possible as long as everyone swims in a different suit. He was more than one and a half seconds faster in the Jaked 01 suit, proving his point. A few days later the French championships were held where the Jaked 01 again performed well. The French swimming association claimed they had no control over the used suits used during the races. All swimsuits authorized for the Beijing Olympics were authorized for these championships thus including the Jaked 01 suit. Alain Bernard however, wore a new suit of Arena, the X-glide that was not yet approved. But during these championships it became clear the LZR Racer was outdated and the Arena X-glide and the Jaked 01 suits from Italian manufacturers were now the fastest suits.

On May 19, 2009 FINA met with the swimsuit approval committee to discuss all suits handed in for testing at March 31. All national federations had been invited to send a representative, Australian Alan Thompson represented the coaches and also the athletes were represented. Immediately after the meeting FINA published a list of all approved swimsuits. 202 suits were approved including the LZR Racer of Speedo, ten models were rejected and 136 models were sent back to the manufacturers for modification to conform to the new rules. Among them, the fully polyurethane Jaked 01, Blue Seventy, TYR and Arena X-Glide suits. Manufacturers had thirty days to resubmit their suits. However, uncertainty remained, athletes still had to wait another five weeks to know if their suits were okay or not and it was unclear what will happen with the records swam in the Arena X-glide since it had never been approved.

The Italian federation announced that despite the ban of the FINA they would allow the Jaked 01 suit at their national trials for the World Championship. The Italian federation had sponsor agreement by Jaked and many athletes already bought the Jaked 01.

On the 22nd of June FINA published a renewed list of approved swimsuits. Surprisingly the Jaked 01 and Arena X-glide were approved without any modifications made. FINA justified their turn around by claiming the time was too short to adequately check the suits. Jaked claimed their

suits were not tested while being worn, skewing the results. However, the executive director of FINA, Marculescu also stated he was under enormous pressure from an enormous business interest. The decision to allow the suits once again did not please everyone. TYR claimed their suit was similar to the Jaked 01 and the Arena X-glide but was not approved and therefore went to court. The US, Australia, British and Dutch coaches expressed their disappointment. Thompson, who was involved in the suit review process and panel who recommended to ban the suits, said the whole process now seemed like a waste of time. Others were also frustrated since it was impossible to get the approved suits in such a short notice before the World Cup in July. Some coaches also saw this decision coming with the World Cup being in Rome, stating FINA probably did not want to ban the suits of the sponsor of the host country. FINA did decide to cancel the world records swam in the suits before approval.

For the US national championships in the beginning of July Speedo allowed their athletes wear suits of their choice just like Nike did a year before. Speedo furthermore made a statement saying they recognized the catastrophic effect and controversy of the fully non-permeable swimsuits by some manufacturers. Speedo always believed there is no place for buoyancy aids and therefore never produced a fully non-permeable suit. They also stated they remain supportive of decisions made by FINA in Dubai for banning the suits from January 2010 onwards whilst allowing some non-permeable materials, and that they will remain committed to growing the sport of swimming at every level.

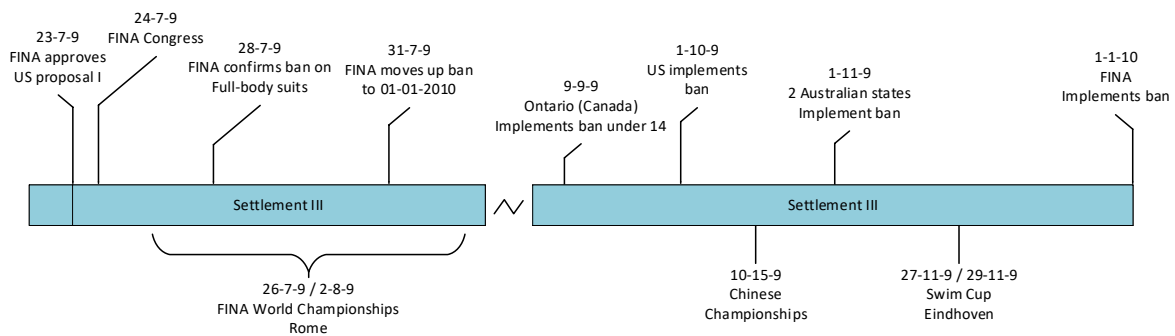


Figure 9 Detailed Timeline swimming part 5

Right before the World Cup in Rome a FINA 24th of July to discuss the proposals by the US from December 2008. The first proposal was about adding the word swimsuit to a ‘device that cannot aid buoyancy’ in FINA regulations. The other proposal aimed to prevent suits from covering anything beyond the shoulders and below the knees and limit materials to textile fabrics only would be discussed the next day. Thompson hoped FINA would provide strong leadership but also stated that it was time for powerhouses US and Australia to take a more active role in deciding the rules and everyone had to step up and say what they think. In the build up to the congress Marculescu claimed the US could propose whatever they wanted but that a swimsuit is not a device but equipment, and a device was clearly defined in the rules. However, a day before the congress Marculescu met with the head coaches from the United States, Australia, Canada, Britain, Netherlands and Russia to map a new strategy and approved the first proposal of the US. The new rules stated ‘No swimmer shall be permitted to use or wear any device or swimsuit that may aid his speed, buoyancy or endurance during a competition’. During the congress, FINA elected a new president, Julio Maglione who was reportedly in favour of regulating swimsuit innovations. That same day he stated that 158 countries backed the second proposal of the US. The decision still needed to be confirmed by the FINA bureau a few days later.

The World Cup started on the 26th of July 2009. Some athletes refused to wear the new suits sticking with their Speedo LZR Racer, including Michael Phelps. Other athletes ditched their sponsors to swim in Arena or Jaked suits. Schubert said it was pure chaos and that he had swimmers running around asking for different suits between heats and finals. During the World Cup, on the 28th of July, FINA confirmed the new regulations preventing suits from covering anything beyond the shoulders and below the knees and limiting materials to textile fabrics only as discussed at the FINA congress in a press conference. The new regulations would be effective from April or May 2010 instead of the planned date of January 1st to allow manufacturers time to make the transition and to clarify some of the new regulations. For example, the definition of textiles still needed to be decided on by a scientific committee. A day later German swimmer Paul Biedermann beat Phelps wearing an Arena X-Glide, outraging Phelps coach Bob Bowman. Bowman threatened to pull Phelps from FINA competitions until new regulations were implemented. 'The sport is in shambles right now and they better do something or they're going to lose their guy who fills these seats.' Two days later FINA announced they moved up implementation of the new regulations to January 1st. They also added that suits have to be approved one year before Olympics and commercially available 6 months in advance.

At the end of the World Cup a total of 43 World Records were set. The winner of the suit war was Arena with 14 gold, 12 silver, 10 bronze medals and 13 World Records. Jaked 01 had 9 gold, 12 silver, 16 bronze and 13 World Records. The LZR Racer finished with 6 gold, 2 silver, 7 bronze and 5 World Records.

Some countries decided to implement the rules even before the end of 2009. In September Ontario (Canada) already implemented the new regulations for competitions under age 14, however, other Canadian states did not follow. The US did vote to implement the new regulations from October 1st onward for all athletes. For the Chinese national games mid-October only five brands were allowed, including Speedo, Nike, Blueseventy and two national brands. At the end of October two states in Australia decided to also expedite the new regulations to November 1st. During the World Short course in Stockholm in November Phelps chose to already wear swimming trunks instead of the high-tech suits claiming he wanted to wear the suit he will be swimming in for the rest of his career. At the end of November at the Swim Cup organized by Jacco Verhaeren and Pieter van den Hoogenband only suits conforming to 2010 rules were allowed. Verhaeren was happy to see athletes competing honestly again.

On the first of January FINA adopted the new regulations eradicating the LZR Racer and its successors.

4.2 ACTOR ROLES

This section provides an overview of the different actors and their roles in the strategic action fields. Per case a table is provided, further justification of the assignments of actor roles can be found in appendix A.

4.2.1 Skeleton

Table 9 shows the different actors and their roles within the strategic action field.

Table 9 Actor roles Skeleton

Actor role	Actors	User/Producer
Governance unit	IBSF International Olympic Committee (IOC)	
Dominant actors	Team GB skeleton Team US	Specific user General user
Challengers	Rival nations	General user
Introducers	UK Sports, English Institute of Sport, Total Sim & British Cycling	Producer
Opponents	Team US Katie Uhleander Latvian Coach 'Rival nations'*	General user General user

* Multiple reports claim rival nations and athletes question suits, without further specification of these nations

Table 9 shows Team GB as a dominant actor, however, important to note is that before this Olympic both the men and women had a low world ranking position. Despite this the women were still medal favourites, Lizzy Yarnolds was a defending Olympic champion and Team GB had had women on the skeleton podium every Olympic since the women's Skeleton event was introduced in 2002. As shown in the table no producers were mentioned to be particularly dominant in this field. Total Sim is active in the field of Cycling and the English Institute of Sport worked together with British Cycling but is not necessarily a producer active in the field of Skeleton. Furthermore, the actual users were not really involved in the process of legitimization and were therefore not labelled as introducers. The suits were exclusively developed for the British Skeleton rides but they did not get a hold of the suits before the Olympics and had to give them back right after use to prevent others from copying the technological innovations in the suit. This shows athletes do not necessarily get a say in what they wear and suits are not publicly available for all athletes to choose from.

Furthermore, it is notable that part of the opponents is another dominant actor, Team US. This opposition was mostly carried by athlete Katie Uhlaender. While for Team GB the discussion was led by a Team GB spokesperson.

4.2.2 Road Cycling

Table 10 shows the different actors and their roles within the strategic action field, actors are assigned based on their role in the 2017 Tour de France.

Table 10 Actor roles Road Cycling

Actor role	Actors	User/Producer
Governance unit	Race Jury/ Race commissaires Union Cycliste Internationale (UCI)	
Dominant actors	Team Sky Chris Froome	Specific user

	Geraint Thomas Sir Dave Brailsford	
	Castelli & British Cycling	Specific producer
Challengers	Movistar	Specific user
	FDJ	General user
	Fred Grappe	
	BMC	General user
	Endura	Specific producer
	Bioracer	General producer
Introducers	Team Sky	Specific user
Opponents	FDJ	General user
	BMC	General user

Table 10 shows that the introducers of the particular skinsuit was a dominant actor who collaborated with a producer for the development of the skinsuit. Additionally, another similar skinsuit was introduced by a challenger actor, Movistar who partnered with Endura. These partnerships also show that skinsuits are made exclusively for particular teams and athletes do not choose their own suits. This was also shown by Sky rider Thomas stating he just wears what is given to him. Furthermore, athletes did not necessarily get involved in the discussion, contention was mostly between Team Coaches. Especially, Fred Grappe, head coach of FDJ had the most active role in the discussion.

Sir Dave Brailsford also played an important role in the case. He facilitated the knowledge spillover from British Cycling to Team Sky in regard to the skinsuit development. However, his involvement also harmed Team Sky's reputation, possibly influencing contention.

4.2.3 Swimming

Table 11 shows the different actors and their roles within the strategic action field, actors are assigned based on their role during the 2008 Beijing Olympics. Important to note regarding table is that actor roles have shifted during the course of the case. Specifically, more producers adopted and developed newer skinsuits which were seen as even more problematic than the LZR Racer. Following these developments more actors joined the opponent group, as also described in the timeline.

Table 11 Actor roles Swimming

Actor role	Actors	User/Producer
Governance unit	Fédération International De Natation National swimming federations	
Dominant actors	Team US	Specific user
	Michael Phelps	
	Team Australia	Specific user
	Speedo	Specific producer
Challengers	Arena	General producer
	Adidas	General producer
	Jaked	General producer
	Blueseventy	General producer
	Nike	General producer
	Other competing countries	Both general and specific users
Introducers	Speedo	Specific producer
Opponents	Arena	General producer
	TYR	General producer
	Dutch Team	Specific user

	Jacco Verhaeren	
	Team Canada	Specific user
	Team France	General user
	Team Italy	General user
Other	Scientific experts	

The introducer in this case was Speedo, a dominant producer. Speedo did partner with Team US and Australia to develop, test and introduce the swimsuits, as they were also their sponsor. In this case however, the suit was not made exclusively for Team US and Australia and was made available to all athletes, something which is demanded by FINA. However, this availability did not necessarily mean athletes had a free choice of swimsuits since many athletes were personally or through their national federation bound to certain producers. Despite this, many athletes still switched their suits from other producers for the LZR Racer. This caused producers to oppose the new swimsuits of Speedo since theirs could not keep up. When the LZR Racer was cleared by FINA these producers rushed to develop their own versions, some performing even better than the LZR Racer.

Even though producers switched from opponents to adopters, Team US and Team Australia eventually became part of the opponent group. Especially Team US who was the first to propose a ban on all non-permeable full body swimsuits.

In this case scientific experts were also involved in the discussions but they not part of the actor roles conceptualized in SAF theory. Their involvement was mostly because they were actively called upon by different strategic actors for conducting research and setting up testing programs.

4.3 LEGITIMACY

In this section the evaluation criteria and eventual legitimacy of the skinsuits in the different cases is discussed. To better understand the legitimacy of the skinsuits this analysis distinguishes between three primary pillars of legitimacy as described by Suchman (1995); Pragmatic, moral and cognitive. For each of these pillars the technologies are scored to make the differences between the pillars for each case more tangible and provide a basis for the case comparison.

4.3.1 Skeleton

As described in the timeline of this case, no real settlement could be distinguished. At the end of contention the suits were still allowed despite complaints. Team GB has a strong partnership with UK sports who provided the skinsuits during the Olympic games but they do not get to use them in other competitions. The GB athletes had to give all equipment back to UK sports to keep the technology a secret. So the suits have not been used since then, it remains to be seen whether the suits will return for the next Olympics. Table 12 shows the evaluation criteria relevant in the discussion regarding the suit and the eventual legitimacy of the suits.

Table 12 Legitimacy and evaluation criteria in Skeleton

Legitimacy	Outcome	Evaluation criteria
Pragmatic	+	Success attributable to the suits
Moral	-	Equal access Unfair advantage Others innovate as well Importance of budget Conforming to regulations Conforming to governance unit decisions
Cognitive	+	Hard work and skills Impact of technology

The technology was *pragmatically legitimate* because of the success it yielded during testing, in the practice runs and in the eventual race. However, experts in aerodynamics also stated that aerodynamics are complicated and the true impact of the suits in Skeleton was difficult to predict. Additionally, the skinsuit was part of a package of innovations, the sleds and runners were also specially made for the Pyeongchang track making it difficult to determine the actual advantage of the suits. Rivals not having access to the same technology did affirm the *pragmatic legitimacy* by blaming the skinsuits for Team GB's success. Katie Uhlaender specifically said she tried to get a suit of that quality but was told it was illegal, she wanted further clarification if the rest could do the same thing. Furthermore, the coach of Latvia stated the 'technological stuff' made the difference for team GB.

For rivals the problem lay more in the *moral legitimacy* of the suits but they may have had *pragmatic* reasons for this since they did not have access to the suits which reduced their chances of success. Rivals thought the suits provided an unfair advantage and felt aerodynamic additions were against the rules and therefore had no place in the sport. Team GB used the confirmation of the IBSF that the suits were compliant with the regulations to show their legitimacy but Team USA felt they took advantage of a grey area in the rule book. A German athlete also commented on this but said everything was checked so Team GB did everything right. He also respected the team for revolutionizing the suits. Others also took this *cognitive* basis further by claiming

technology and innovation is always key in equipment sports such as skeleton but hard work and skills remain most important.

The Guardian, two days after they published the article featuring the skinsuits, took a more critical stance questioning the *moral legitimacy* of the high funding British Skeleton enjoyed. They questioned whether the 6,5 million pounds in funding for Skeleton was the best way to spend public sports money. Others followed this and questioned how much of success in elite sports could be attributed to money.

Concluding, *pragmatic legitimacy* of the suits was high especially from the perspective of users of the suit. However, the true impact of the suits was difficult to predict in Skeleton, also since the suits were part of a package of innovations. Additionally, because the suits were specifically made for Team GB athletes for the Olympics there were only a very limited number of users. Therefore, pragmatic legitimacy is scored as a single plus. The *moral legitimacy* of the suits but also the funding making these suits possible was challenged, therefore this was scored as a minus. Furthermore, the *cognitive* basis that innovation is key in equipment sports legitimized this suit and other innovations used by Team GB and is therefore scored as a plus.

4.3.2 Road Cycling

The Vortex suit was eventually banned by updated regulations by the UCI restricting aerodynamic attachments for clothing. However, at the time of the rule change the suits were not in use anymore. Table 13 shows the evaluation criteria relevant in the discussion regarding the Vortex suits.

Table 13 Legitimacy and evaluation criteria in Road Cycling

Legitimacy	Outcome	Evaluation criteria
Pragmatic	+	Success attributable to the suits
Moral	--	Equal access Unfair advantage Not new nor unique Performance enhancing Conforming to regulations Conforming to governance unit decisions
Cognitive	++	Marginal gains Impact of technology

During the 2017 Tour de France the suits yielded success in the first time trial, showing it's *pragmatic legitimacy*. However, this did not become apparent in prior races where the suits were also used. *Moral legitimacy* was questioned only after the technology used in the suits became visible because of the rain. Followed by pragmatic claims on the effect and impact of the suit on performance which led to moral discussions on the equality and performance enhancing aspects of the suit. However, Movistar admitted to using similar suits, but these were not questioned by others, showing pragmatic reasons for challenging the legitimacy of Sky's suit.

The updated regulations by the UCI further decreased the *moral legitimacy* at the time of settlement because it no longer conformed to regulations and is therefore scored as a double minus. During the 2017 Tour de France the suits yielded successes but at the time these new regulations were introduced *pragmatic legitimacy* of the specific suit was low. Castelli, the producer, claimed they already had a better, faster suit conforming to updated regulations. Steve Smith, Castelli's brand manager however did state the new suit was specially made for the

upcoming time trials but would have been less favourable for the time trial in Düsseldorf. If the riders would ride the Düsseldorf time trial the Vortex would have been faster showing the Vortex's *pragmatic legitimacy* was not completely lost and is therefore scored as a plus.

Although the suit itself was not seen as legitimate any more, the innovation process of improving aerodynamics in suit design was still seen as legitimate. After the Tour, Endura released their 'most aerodynamic kit yet' improving aerodynamics using silicon chevrons on the shoulders, arms, sides and thighs. Sky together with Castelli introduced a skin-tight suit without aerodynamic additions to replace the Vortex for the 2018 Tour de France. Bioracer also introduced a new speed suit making use of speed silk and other aerodynamic additions which was not banned by updated regulations.

This shows that the legitimacy of innovative skinsuits in general has a more *cognitive* basis since innovation have generally been accepted as a big part of cycling, especially in Time Trials. Every team innovates and makes use of wind tunnel testing to get the edge over competitors, not only in suit design but also for bikes, wheels and other equipment and is therefore scored as a double plus. The problem with Team SKY's Vortex came mostly from the lack of *moral legitimacy* of their interpretation of the regulations regarding aerodynamic attachments.

4.3.3 Swimming

The LZR Racer was a tipping point in swimsuit innovations eventually causing regulations to be tightened. Table 14 shows the evaluation criteria relevant in the discussion leading to the rule change.

Table 14 *Legitimacy and evaluation criteria in Swimming*

Legitimacy	Outcome	Evaluation criteria
Pragmatic	++	Success attributable to the suits Attractiveness of sport
Moral	-	Impact of suits on performance Impact for junior competition Equal access Conforming to regulations
Cognitive	--	Part of progress Records lose meaning Purity of swimming

Pragmatic legitimacy of the suits was very high, shown by the success of swimmers in the suit and by the many swimmers switching to the LZR Racer despite their contracts with other sponsors. Furthermore, not only the LZR racer itself but the materials and innovations incorporated in the suit had *pragmatic legitimacy*, shown by the rush of manufacturers to create their own versions that also enjoyed many successes. Therefore, the *pragmatic legitimacy* is scored as double plus. The problem for the LZR Racer lay more in the *moral* and *cognitive legitimacy*.

Moral legitimacy was challenged on multiple grounds. First of all, opponents felt there was an unequal access to swimsuits among swimmers. Equal access to swimsuits is formally institutionalized in swimming, FINA rules dictate swimsuits should be available to all athletes. Speedo did make the suits available to everyone, even for free. However, many swimmers were bound to certain producers because of national federation or personal sponsor deals. Some still felt that this equal access would solve itself since eventually every athlete would wear similar

suits levelling the playing field. For competitions outside elite swimming such as junior or college competitions the high price of the suits was also seen as a *moral* problem since not everyone would be able to afford the suits. Other arguments claimed that the suits impacted performance too much and were therefore not desirable. Additionally, during the first months of contention claims were made that the suits were against regulations, despite FINA clearing the suits on different occasions. Which caused the legitimacy of the regulations and the FINA to be questioned. The case showed different problems regarding the moral legitimacy but some defended this legitimacy, therefore *moral legitimacy* is scored as a minus.

Additionally, many actors first in favour of the LZR Racer, started questioning the legitimacy of the suits successors, the regulations and the FINA for letting things get out of hand. Because of the contention, *cognitive* ideas on what swimming should be became more important. Many felt that swimming should be a pure sport based on talent and hard work and should not turn into a sport where a swimmers budget and equipment is decisive. Some athletes even refused to wear the suits in competition knowing it would impact their chances of winning. This showed that the regulations and the suits did not fit with current *cognitive* ideas and therefore were no longer legitimate. Therefore, *cognitive legitimacy* is scored as a double minus.

4.4 INSTITUTIONAL STRATEGIES

In this section the strategies employed by the different stakeholders to (de-)legitimize the technology are discussed based on the five strategies described by Pelzer, Frenken & Boon (2019).

4.4.1 Skeleton

Table 15 provides a summary of the strategies employed by actors during the contention.

Table 15 Institutional Strategies in Skeleton

Strategy			Actors
Framing	Positive	Suit is within the rules	Team GB
		Others innovate as well	Team GB athletes
	Neutral	Revolutionary skinsuits with massive aerodynamic gains	Team GB athletes, The Guardian & other media outlets
		Dispute is a strategic move	Darrin Steele (USA) & Team GB
Negative	Suit is illegal	Team US, Latvian Coach & 'rivals'	
	Suit made the difference for Team GB	Latvian Coach	
Theorization		Team GB win will go down poorly	Media
Collaboration		English Institute of sports and TotalSim	English Institute of sports & TotalSim
Lobbying		Publicly questioning legality	Katie Uhleander (USA)
Negotiation		IBSF captains meeting	IBSF and all competing countries
Governance unit actions		Checking and clearing suits for use	IBSF

Framing

Different ways of framing the skinsuits and the rules were used during the episode of contention. First of all, at the first day of practice runs, the Guardian published an article discussing the skinsuits of Team GB framing it as a revolutionary skinsuit, which contributed to the eventual onset of contention.

“ Great Britain's skeleton riders will pursue Winter Olympic gold this week aided by the latest version of the revolutionary skinsuits ... the Guardian can reveal. The custom made aerodynamic suits provide a "massive" improvement on the conventional ones - with riders expected to benefit by as much as a second during each of their four skeleton runs in the Games” - The Guardian (Ingle, 2018a)

They spoke with Team GB athletes who said the suits benefited as much as a second per run, which was quickly picked up by other media. Later, Team Gb athletes toned this down a bit. Parsons mentioned that the technologies did make an impact but that it was all about marginal gains. He also followed that the impact of technology was overplayed and that sliding techniques and hard work were much more important which was backed by his fellow athlete Jerry Rice.

Following the article published by The Guardian, Katie Uhlaender (US) openly questioned the legality of the skinsuits used by Team GB on Twitter. Even when the IBSF cleared the skinsuits for competition she still framed the suits as being illegal, by citing regulations and saying she

tried to get a similar suit but was told it was illegal and wondered if others could do the same thing (regarding the suits).^[S1]^[S2]

"The rules state that everyone is supposed to have access to the same equipment as far as helmets and speed suits go, and not have any aerodynamic attachments on the helmet or in the suit, I'm not a scientist, I just know that I was trying to get a suit of the same quality and I was told that it was illegal, and now it's legal," – Katie Uhlaender (Ingle, 2018b)

Different media outlets also reported that 'rivals' questioned the legality and legitimacy of the skinsuits however no other athletes or teams were specifically mentioned. Also they mentioned rivals claimed the suits provided an unfair advantage without clear sourcing of who those rivals were. The Canadian team did question the legality in private during the practice runs but did not pursue this any further. Katie herself also stated that others questioned the legality, but it remains unclear who those others were. After the finals a Latvian coach framed the suits as responsible for Team GB's medal in the men's final and added to this that the IBSF was weak for not ruling, claiming the suits were illegal.

Team GB contested the framing of the suit being illegal, issuing a statement saying their suits were within the rules saying they did not make use of illegal aerodynamic attachments. Jerry Rice and Parsons added to this by framing the suit simply as an innovation that everyone tried to achieve but could not. They stated that every country innovated but that the British just accomplished what everyone was trying and therefore did nothing wrong.

Darrin Steele (US) framed the suit and the publication of the Guardian article as a strategic move from Team GB to throw of the competition.

"It's about who can throw down despite distractions, and we'll see who comes out on top over these next few days. The timing of the article [in Monday's Guardian] was perfect and a smart strategic move by the British team." – Darin Steele (The Times, 2018)

He explained a large part of the sport is mental strength and because of the article many athletes from different countries are now talking about the suits instead of focusing on the race. Team GB framed this the other way around. Claiming rivals questioned the legality of the suits to get in Team GB's head.

Theorization

Media theorized that if Team GB would win it would not just be accepted because of the suits, however, there was little to no protest after Team GB took three medals. Apart from some comments by the Latvian coach.

Collaboration

During the contention no collaboration was identified. Collaboration was mostly important in developing the skinsuits where the English institute of Sports collaborated with TotalSim who already worked with British Cycling.

Lobbying

By publicly questioning and citing the Skeleton rules on Twitter, Katie Uhlaender (US) made the situation notable to the IBSF and asked for clarity regarding the skinsuits from the IBSF.

Negotiation

The IBSF captains meeting on the evening before competition started provided an opportunity for negotiation on the suits. However, none of the opponents used this opportunity and no comments regarding the suits were made.

Governance unit actions

After the practice days the IBSF stated the suits were checked and cleared for competition and did not further interfere in the discussion.

4.4.2 Road Cycling

Table 16 provides a summary of the strategies employed by actors during the contention.

Table 16 Institutional Strategies in Road Cycling

Strategy			Actors
Framing	Positive	Elements are integrated not added	Team Sky & Tour Commissioners
		Not new nor unique	Team Sky, Castelli & Movistar
		Innovation is part of the sport	Team Sky, Producers & Media
		Aerodynamics are complicated	Team Sky, Castelli & Trek
	Negative	Suits are illegal	FDJ, BMC
		Rules are vague	Tour Commissioners
		Unfair advantage	FDJ
Theorization		Rules should be applied or we will see all kinds of additions	FDJ
		Team Sky would not risk everything by cheating	Team Sky
		If Sky's suit is banned ours should too	Movistar
Collaboration		Rivals protesting to the jury together	FDJ & BMC
		Development of Vortex suit	Team Sky & Castelli
Lobbying		Rivals taking it to the jury	FDJ & BMC
		Rivals asking for re-evaluation of the rules	FDJ & BMC
Negotiation		Team Sky processes approval in advance for 2018	Team Sky
Governance unit actions		Race Jury checking and clearing suits	Tour Commissioners
		Race Jury passing the ball to the UCI	Tour Commissioners
		UCI evaluating the rules	UCI
		UCI tightening regulations	UCI

Framing

During contention different actors engaged in framing in an attempt to influence the legitimacy. First of all, after the first Time Trial, FDJ together with BMC publicly framed the Vortex as illegal, claiming the rules were clear and Sky's use of aerodynamic additions were against the rules.

"The rule is very clear. Any aerodynamic addition to the jersey is banned. Sky have clearly infringed." – Fred Grappe (Fotheringham, 2017a)

This was later picked up upon by L'Equipe, an acknowledged French sports paper running headlines a day after the Time Trial that Sky was accused of cheating. Also after Tour Commissaires confirmed the legality, FDJ kept insisting the Vortex was against the rules.

In a reaction to the allegations, team Sky insisted the legality of their suits and framed the aerodynamic elements as integrated, not added to the suit, which was affirmed by race commissaires. However, race commissaires did frame the suit as being in regulatory grey area claiming there was a legal vagueness.

“We examined the skinsuits and it [the vortex generator] is integrated into the fabric, so it's not really a violation of the UCI rule. I can understand the rationale of other teams, but for the moment, we have no real way of forbidding it.” – Philippe Marien (Business Mirror, 2017)

Media reported the frame of the additions being integrated but also questioned this interpretation and emphasized the vagueness of the rules, some stating Team Sky took advantage of this.

Furthermore, FDJ not only framed the suits as illegal but also as an unfair advantage by citing scientific studies, also taking this to Twitter after the first Time Trial. Fred Grappe stated wind tunnel test proved the suits would provide a huge advantage. He claimed the dimples on the sleeves and shoulders, could improve the coefficient of air penetration in the jerseys by up to seven percent resulting in a 18 to 25 second advantage in the first time tria^[S3]^[S4]l.

“It's enhanced aerodynamics and the regulations forbid it. According to studies, the estimated gain is about four to seven per cent. It's huge... This gain [18 to 25 seconds], I am not making it up. I measured it in a wind tunnel.” – Fred Grappe (Lawton, 2017; La Tribune de Geneve, 2017)

A professor in aerodynamics backed this claim but other researchers stated Grappe referred to papers measuring this in a different setting. Team Sky and Castelli, but also rival team Trek framed aerodynamics as complicated and stated these times were difficult to measure. Dave Brailsford of Team Sky also framed time gains mentioned by Grappe as insane and untrue. Despite being true or not the claims made by Grappe were heavily picked up by media. Multiple media sources reported the Vortex provided a power gain of four to seven percent resulting in a 18 to 25 second advantage.

Another way Team Sky and Castelli framed the suit was that it was not new nor unique. They claimed they used the suit before and that other teams used similar technologies. Media outlets also reported that these technologies were used in cycling before and Movistar, a rival team also admitted to using similar equipment. Furthermore, Team Sky framed the suits as being innovative and part of the sport. Other producers also pushed this frame saying the Tour was always a huge site for innovation especially in Time Trials, which was also confirmed by some media outlets.

Theorization

FDJ also engaged in theorization, Grappe said the rules had to be applied otherwise all kinds of aerodynamic additions would be used in the future. Regulations needed to be tightened to prevent innovation getting out of hand.^[5]

“The commissaires should do their jobs and apply the rules. If not, we’ll go to Marseille and we’ll see skinsuits that modify the shape of the back and the shoulders, and they’ll be going quicker, you will be able to modify the shape of the body by inserting pads into the skinsuit, and they’ll say that if it’s integrated as part of the skinsuit, then that’s ok.” – Fred Grappe (Business Mirror, 2017)

Team Sky also engaged in theorization explaining they would not have risked the whole Tour by cheating therewith trying to show their legitimacy. In between the two Time Trials, Movistar shortly engaged in theorization saying that if Team Sky’s suits would be banned theirs should be as well since they used similar suits.

Collaboration

Although Team Sky and Castelli did not actively engage in legitimizing strategies during development or introduction of the suit, Castelli did collaborate with Team Sky in developing their skinsuits. FDJ and BMC used collaboration to form a front to the Tour Commissioners but did not pursue this collaboration any further.

Lobbying

After the first Time Trial, FDJ and BMC took their complaints to the jury and actively asked for interference from the Tour Commissioners and later the UCI. Hereby promoting their own interpretation of the rules opposed to that of Team SKY.

Negotiation

When Castelli and Team Sky introduced the Vortex suit they did not actively seek legitimacy for it apart from getting it cleared with race officials. For the 2018 tour Team Sky employed this strategy more actively and processed their approval in advance instead of at the race to make sure it was legit.

Governance unit actions

Tour Commissioners checked and cleared the suits of Team Sky also framing the aerodynamic additions to be integrated not added. However, they also recognized the vagueness of the rules. Consequently they threw the ball at the UCI to rule before the next Time Trial but did validate the results of the first Time Trial. The UCI then investigated the claims but eventually stated the suits were compliant right before the second Time Trial commenting the suits were already checked and used before. Two seasons later the UCI tightened regulations making the Vortex and other similar suits non-compliant.

4.4.3 Swimming

Table 17 below provides a summary of the strategies employed by actors during the contention.

Table 17 Institutional Strategies in Swimming

Strategy		Actors
Framing	Positive	Stating the superior features of the LZR Speedo and Team USA and Team Australia athletes

	Producers promote suit at competitions	Speedo, TYR
	Progress is good	FINA
	Successors of LZR were a problem	Speedo
Neutral	Suit is pure marketing	Speedo
	Letting sponsored athletes wear other suits	Nike & Speedo
	Nike leaves elite swimming	Nike
Negative	Technological doping	Alberto Castagnetti (Coach, Italy)
	TYR goes to court	TYR
Theorization	Not competitive without the suits	Several Olympic coaches and Athletes
	Records will mean less because of the suits but it will still be about racing	Mark Shubert (Coach, USA)
	Suit distracts from doping cases	Gary Hall jnr (Olympic, USA)
	Research on impact of suit	FINA, Italian Olympic Committee, Arena & scientific community
	Suits could be developed to interact with the body	Scientific experts
	Suits challenge credibility of swimming	European and Australian coaches
	If ban was not implemented USA would have acted	Lafontaine (Coach, Canada)
	Ban would be a step backward two decades	Speedo
	Full ban would be bad for commercial sport	Alan Thompson (Coach, Australia)
Collaboration	European coaches sign petition backing the USA proposal and Australia joins	European coaches, swimming USA and swimming Australia
	FINA collaborates with all stakeholders for new regulations	FINA
	Manufacturers unite	Producers
Lobbying	Arena calls for proper analysis of the suit	Arena
	USA vows for ban on suit	US Swimming federation
	Threatening with consequences if FINA does not ban suit	Bob Bowman (Coach, USA), Adidas
Negotiation	FINA meetings with manufacturers and coaches	FINA, producers & coaches
Governance unit actions	National governance units make alternative decisions than FINA	National swimming federations
	National governance unit decide which suits athletes can wear	National swimming federations
	Providing multiple statements on the legality of the swimsuits	FINA
	FINA introduces new measures	FINA
	FINA set up test and control program	FINA
	FINA allows banned suits again	FINA
	FINA elects new president	FINA

FINA announces tighter regulations	FINA
FINA switches dates for implementation of new regulations	FINA

Framing

The launch of the LZR Racer was a big marketing operation of Speedo. They launched the suit in three cities simultaneously with USA's and Australia's top swimmers to promote the

"When I hit the water, I feel like a rocket" – Michal Phelps
"It's like swimming downhill" – Libby Trickett
"When I put it on, I feel like a superhero" – Ryan Lochte
"You feel so streamlined through the water, it's like you're cutting through the water like a hot knife through butter" – Grant Hackett
(James, 2008; MX, 2008; Agence France Presse, 2008)

suit[S6][S7][S8].

The whole launch was a framing activity to promote the suit as the world's fastest suit using multiple scientific claims such as; swimmers are up to 5% more efficient in their oxygen intake and the suit has 5% less drag than the previous model. The suit itself was also a way to frame the brand Speedo as the world's best. In essential the suit was purely a marketing tool to increase sales for regular swimwear to non-elite athletes.

Speedo continued this promotion by pitching their suits at the USA Olympic trial to promote the benefits at potential users, a strategy also employed by TYR. During the Olympics several manufacturers were also on hand at the pools providing suits to all athletes. Speedo even offered free suits to every athlete that wanted one.

Two months after Speedo introduced the LZR Racer, FINA looked into the suits but stated there was no reason to ban the suits. They framed the assault on the records as progress and positive for the sport. Alberto Castagnetti called the suits not progress but framed them as technological doping. A frame that media picked up quickly[S9].

"This is going down a very dangerous road, It removes the purely competitive aspect of the sport and puts outside factors into play. Swimming has always been based on ability. Now, there are other aspects. It's like technological doping. It's not in the spirit of the sport." - Alberto Castagnetti (Dampf, 2008a)

On two occasions suit manufacturer TYR went to court because of the swimsuits. The first time, a month before the US Olympic Trials, TYR sued Speedo and the US Swimming federation for conspiring. Months later when FINA renewed the list of approved swimsuits TYR went to court again. Their swimsuits were rejected so they asked a French court to appoint an independent legal expert to determine why some similar suits from other manufacturers were approved by FINA and TYR's were not. Although TYR did not aim the lawsuits against the LZR Racer specifically it did put Speedo in a negative light. With the second lawsuit TYR framed their suit as similar than others and put the FINA in a bad light.

When the discussion shifted, framing also shifted. During the US championships, the year after the Olympics, Speedo released an official statement regarding suits of other producers framing their own LZR Racer as non-problematic. [S10]

"We recognize the catastrophic effect and controversy that the introduction of fully nonpermeable wetsuits by certain manufacturers has had on the sport of swimming in recent months," the statement said. "Speedo has always believed that there is no place in the sport for buoyancy aids." – Speedo (Newberry, 2009)

For the US Olympic trials and eventually the Olympics Nike allowed their sponsored athletes to wear suits of their preference instead of holding them to their sponsor agreement. By doing this Nike framed themselves as a company caring about their athletes. Following this decision many sponsored Nike athletes switched to the LZR Racer for the Olympics. Speedo also did this when their LZR Racer became inferior to newer suits from rival producers. Nike did however leave the elite swimming market after the Olympics. They claim this had nothing to do with the LZR Racer but was merely a result from their long-term growth strategy.

Theorization

Theorization was a frequently used strategy by multiple actors. After the first successes of the LZR Racer many Olympic coaches and athletes mentioned they felt athletes would not be competitive without the LZR Racer. Mark Schubert (USA) stated he advised all US athletes to wear the suit during the US Olympic trials or they would not make it to the Olympics. [S11]

"I would strongly advise them to wear the suit at trials, or they may end up at home watching on NBC" – Mark Schubert (Dampf, 2008b)

Many athletes dropped sponsors before the Olympics purely so they could swim in the LZR and also whole Olympic teams switched sponsors to wear the LZR Racer during the Olympics. Competitor Nike even let their athletes wear the LZR to make sure they could perform their best at the Olympics.

In response to the assault on the records book triggering complaints from opponents, Mark Schubert (USA) explained records would mean less but that competitions would be more about racing. USA Olympic Gary Hall had a different opinion and stated the suits distracted from potential doping cases since sudden successes would be explained using the suits.

On multiple occasions actors called for more in depth scientific research on the swimsuits actively involving scientific experts in the discussion. At the first moment of re-evaluation of the suits two months after its introduction, FINA stated they were always open to expertise and scientific evidence regarding the advantage the skinsuits provided so they could act accordingly. Consequently, Arena called for a reliable and transparent analysis of the swimsuits before their approval using an open letter published in several newspapers. Right before the Olympics, the Arena sponsored Italian Olympic committee took matter into own hands and announced that they would conduct an in depth study on the impact of the new LZR Racer. After the Olympics FINA took action and collaborated with some universities to provide more insights on the impact of the LZR Racer and new ways of testing and assessing swimsuits.

Scientific experts in fabric engineering said swimming could be headed a dangerous road if FINA did not intervene. They explained that swimsuit fabrics could be designed to interact with the body. It was said FINA's regulations were unfit to regulate current and future swimsuit developments. [S12]

"The potential to enhance performance well beyond current achievements is vast, suits can edit the signals going to the brain, suggest signals or amplify signals. This technology is not being used in sport at this time, but is in the military, medically, and in space. It's not science fiction. It exists. Fina rules are unfit for the present, let alone the future – Sunday Times Expert interview (Lord, 2008)

After the Olympics the discussion shifted and the opponent group grew stronger and European coaches stated the swimsuits challenged the credibility of swimming. Expressing the fear that the suit would become more important than the athlete. Swimming used to be a sport where talent, hard work and training were key but this could now be replaced by just putting on a suit. Dutch Olympic Pieter van den Hoogenband already mentioned the suit helped less talented swimmers to swim fast.

Three months after the Olympics, US Swimming federation drafted a proposal to put a ban on the full-body swimsuits. Speedo claimed a ban would set back swimming two decades and Alan Thompson (Australia) agreed a full ban would mean no records would be swum the next ten years, which would have huge commercial impact but he was happy brakes were appropriately applied to technology in swimming. Lafontaine stated that if FINA did not implement the USA's proposal national federations would have acted themselves.

Collaboration

As mentioned three months after the Olympics, the US swimming federation drafted a proposal for stricter regulations. Later that month at the European Short Course Jacco Verhaeren, in consultation with his Australian and US colleagues drafted a petition to regulate swimsuit technology. In response FINA sought to collaborate with all stakeholders to come to a unified decision regarding the suits. They also included universities to provide insights on new ways of testing and assessing swimsuits. Manufacturers also decided to form a unified front in asking for clear-cut rules on suit innovation, preliminary to the FINA summit in Switzerland.

Lobbying

The lobby for stricter regulations started with the French technical director of swimming Claude Fauquet called on FINA for an ethical debate about the new swimsuits within the first few months after the LZR's introduction. Shortly after Arena called on FINA for a proper analysis of the new swimsuits using a full page advert in some of Europe's leading newspapers. They asked for the new generation suits to be banned pending further testing of its impact.

Three months after the Olympics, the US swimming federation drafted a proposal eventually backed by Australia, Canada together with the petition signed by almost all European coaches lobbying for stricter regulations by FINA. Further lobbying came in the form of threats as during the FINA World Championships in Rome, Michael Phelps's coach threatened to pull Phelps from FINA competitions if they did not implement the announced new regulations sooner. Adidas already resorted to this strategy by stating they would leave elite swimming if FINA did not introduce fair and professional regulations.

Negotiation

Over the course of the case FINA negotiated with many key stakeholders to address the suit issue. FINA met with manufacturers, swimming coaches and other swimming experts on multiple occasions to discuss regulations and conditions for swimsuits. Most of the meetings were pre-planned periodic meetings but the swimsuits were always high on the agenda.

Governance unit actions

Shortly after the introduction of the LZR Racer, national Olympic trials were held in multiple countries. Because of the unclarity regarding the advantage the suit provided some countries decided to not allow the LZR Racer at their national trials despite FINA clearing the suit. When FINA eventually set a date for the implementation of new regulations banning the full-body swimsuits some countries decided to already implement the new regulations immediately instead of waiting for the implementation date of the FINA.

National swimming federations also had a say in which suits their athletes could wear in international competitions. Some federations denied their athletes the right to choose for themselves because of sponsor contracts and imposed heavy fines on athletes wearing other suits. This caused many athletes to feel disadvantaged by their own federations. Some countries however, dropped sponsors to make sure their athletes could swim in the suits of their choice.

Besides multiple forms of collaboration and negotiation with stakeholders FINA also engaged in other actions regarding the swimsuits. They held up the legality of the LZR Racer and its successors for a long time, in multiple official statements. More than half a year after the Olympics they finally introduced new measures and set up a testing and control program for the swimsuits to live up to these measures. Based on these new tests FINA published a list of approved swimsuits but a month later FINA allowed multiple suits that they previously banned claiming they did not have enough time to properly evaluate them.

Right before the World Cup in Rome FINA elected a new president in favour of tighter regulations and at that same congress the USA proposal was approved. However, during the World Cup FINA announced they would only implement the new regulations in May 2010 to the disappointment of many. Consequently, three days later FINA moved up the implementation to January 2010.

4.5 CASE COMPARISON

This section summarizes the results and describes the differences and similarities seen between the three cases based on the analysis. First the actors involved in the cases will be discussed and compared. The same is done for the legitimacy for the three cases. Following, the strategy analysis will be compared using the timeline as a structural basis.

4.5.1 Actors

Actors were categorized based on the concepts from strategic action fields, on top of that distinction was made between different types of users and producers.

In all cases the governance units were the sports federations. Only in the Swimming case national federations sometimes acted independently of the FINA regarding skinsuits decisions which was not seen in the other cases. The other cases however, mostly played out in one moment of competition not involving other governance units.

In all cases the new skinsuits were introduced by a dominant actor as a way to keep their dominant position. In the Cycling and Swimming case, complaints were raised by challengers as expected in SAF theory. In the Skeleton case however, complaints were raised by Team USA, another dominant actor. In the Skeleton and Cycling case the producer collaborated with a specific dominant team to develop and introduce the skinsuit making the introducers a combination of users and producers. However, although the real users, the athletes, were involved in the development, they eventually had little choice in what they wore. In the Skeleton case, the athletes do not get a hold of the suits before the Olympics and had to give them back right after use to prevent others from copying the technological innovations in the suit. In the Cycling case, Froome and Thomas both stated they just wear what is given to them. Both these cases show the athletes have limited influence on what suits they use. This was also shown in the engagement in strategic actions. In the Cycling case mostly the staff from the different teams engaged in action regarding the skinsuits. Team Sky athletes did respond to the commotion but were not actively involved. Also the opposition came from BMC and FDJ staff, their athletes did not engage in any activities regarding the skinsuits.

In the Swimming case, Speedo, a dominant producer, also collaborated with dominant users, Australia and the USA, but their suits were not exclusive to these dominant teams. So in the Skeleton and Cycling case user-producer relations regarding the skinsuits ensured exclusivity while with the LZR Racer suits were available for all teams, a principle formally institutionalized in the field of swimming by FINA. This made the role of users different. Athletes had more saying in their choice of suits. Some athletes switched sponsors, protested to their national associations regarding the suits chosen for them and some athletes protested the suits by wearing older suits during competition. Although some athletes were free in choosing their suits other athletes were limited by the possibilities their personal and/or national federations sponsor deals and risked heavy fines for choosing otherwise. Also, these actions were not necessarily aimed at (de-)legitimization of the new generation swimsuits but at maximising their performances. More strategic actions still came from head coaches and national team staff, not athletes.

Besides influencing the role of users, the non-exclusivity of the LZR Racer also provided a different role for producers. In this case other producers in the field were also part of the opponent group while in the Skeleton and Cycling case contention was only between the competitors in the context of the sport. This caused more traditional aspects of technological innovations such as intellectual property rights, first mover advantage and adoption to become more important. The LZR Racer was protected by sixteen patents making it difficult for other

producers to make a similar suit. Also the LZR Racer enjoyed a high adoption rate when it was just introduced but when other producers caught up and made even better suits athletes and federations quickly switched.

4.5.2 Legitimacy

Table 18 provides an overview of the eventual legitimacy of the three cases based on the three pillars of legitimacy.

Table 18 Overview of legitimacy scores for all cases

Legitimacy	Skeleton	Road Cycling	Swimming
Pragmatic	+	+	++
Moral	-	--	-
Cognitive	+	++	--

As can be seen in all cases the suits were seen as pragmatically legitimate, shown by the yielded successes. The suits were mostly challenged on their moral legitimacy. The evaluation criteria for this moral evaluation were very similar in the Skeleton and Cycling case. A remarkable difference in the three cases was the interpretation of equal access. For Skeleton and Cycling this was interpreted as that everyone should follow the same rules regarding innovation and have equal opportunities to innovate and use similar technologies. Exclusive collaborations between users and producers were not necessarily frowned upon. While in swimming this was more formally institutionalized as FINA rules stipulated all suits had to be available to all competitors at the time of competition.

Furthermore, in all cases cognitive legitimacy proved important for the eventual settlement. In cycling innovations in equipment and improving aerodynamics is common practice and therefore accepted. For Skeleton this was similar since innovation and equipment is always key in a sport like Skeleton where equipment is a precondition for the sport. In the Swimming case this posed a bigger problem. Swimming was always seen as a pure sport where equipment did not play a role and the LZR Racer changed that. So the LZR Racer and the eventual impact it made on swimming as a whole did not fit with cognitive ideas on what swimming should be making the suit illegitimate for many.

4.5.3 Onset of contention

In all three cases the onset of contention did not start with the ‘innovative action’ by an actor but only when this action was visible to rivals in combination with the success this yielded. In the Skeleton case, the suits were noticed because of the strong practice runs of the British athletes in combination with the publication of the Guardian article framing the suit as superior quoting Team GB athletes. In the Cycling case, the suits were already used in other seasons and were only questioned after the dimples were clearly visible because of the rain and the Team Sky riders performed well in the Time Trial. In the Swimming case, Speedo drew lot of attention to the suits and by its flashy introduction framing the suit as ‘world’s fastest swimsuit’ using their top sponsored athletes. Rivals did not immediately question the suits right after introduction. Only when athletes in the suits performed really well, contention started.

While developing the suits the actors claimed to not violate field rules, but in all cases they were accused of stretching formal rules and operating in a grey area. This rule stretching was possible due to the ambiguity of the rules. As discussed in the theory section, it is impossible for governance units to anticipate every new innovation and capture these in rules and regulations.

Because of the secrecy regarding the innovation process and the introduction shortly before important competitions governance units have to respond ad hoc to new innovations and are the only actors evaluating the new suits ex ante. They do this based on their own interpretation of regulations. Other actors who might had a different interpretation could only engage in sensemaking when suits were already used for competition. This caused contention over the new suits and rule interpretations to coincide with competition, leaving little room for an open debate and evaluation of the suits before the actual use of the suits. Introducing suits just moments before competition is done because of secrecy as seen in the Skeleton case, but this was combined with a news article in *The Guardian* disclosing the skinsuits. In Cycling the suits were not introduced as publicly as in the Skeleton and Swimming case which could also be seen as a strategy. By not putting the suits in the spotlights complaints only raised when the suits had already been used.

Even though governance units responded ad hoc to the new innovations, in all three cases the suits were not completely new. In the Cycling case similar innovations were already used for the London 2012 Olympics in Track Cycling by British Cycling, which is even under the same governance unit, the UCI. Furthermore, problems regarding the ambiguity of regulations were known as mechanics regularly complained that at bikes that get passed at one Time Trial and get rejected at another. The Skeleton suits were also based on British Cycling suits already used six years before they were introduced in Skeleton. Also, in 2010 and 2014 the British athletes already wore precursors of the 2018 suit. Additionally, in 2010 Skeleton experienced a similar discussion regarding Amy Williams helmet. In swimming the first full body swimsuits were approved in 2000 and innovation and development continued for the following years. Furthermore, at least in Cycling and Swimming the governance units already checked and approved the suits before contention even started. This shows in all cases governance units could possibly have anticipated discussions regarding the contended skinsuits.

4.5.4 Episode of contention

In the Skeleton and Cycling case, one clear episode of contention was identified regarding the specific skinsuit while in the Swimming case multiple episodes of contention followed each other. During the episode of contention multiple stakeholders employed different strategies to influence the legitimacy of the skinsuits.

In every case, framing and theorization strategies were employed. Important aspects of framing in all cases are scientific claims regarding the material features and qualities, used by both introducers as opponents. When looking at the strategies employed in the Skeleton case, actors do not really progress past framing and theorization. In Cycling and especially in the Swimming, theorization went beyond innovation-level theorization to more field-level theorization taking a prospective outlook on what these developments could mean for the future of the sport. In Cycling, collaboration, lobbying and negotiation were employed by the opponents at the moment they raised complaints to the Tour Commissaires but these strategies were not pursued further after this. On the contrary, in the Swimming case actors engaged in these strategies more often than in the other two cases. Collaboration between different actors were pursued more formally by for example, organizing official meetings, drafting petitions and formal proposals for regulatory changes. This course of strategies engagement also relates to the timelines of the cases. The episode of contention in the Skeleton case was over the course of a week, in the Cycling case, this was a month while in Swimming contention continued for almost two years.

An explanation for this difference could be found in governance unit actions. Although these are not clearly defined in SAF theory besides facilitating settlement in some cases, they do seem

crucial for the course of the episode of content in the different cases. In the Skeleton case the IBSF cleared the suits for use and did not necessarily leave room for further discussion. The Team GB skinsuits were cleared for competition and the IBSF did not engage in further action regarding the skinsuits. In the Cycling case, the suits were cleared by the Tour Commissaires but at the same time the head commissaire claimed he had no legal certainty to prohibit them. He added the commissaires had no authority to further judge the matter and passed the ball to the UCI. By passing the ball to the UCI, race commissaires partly lost their formal authority and therefore provided the opportunity for further discussion. Additionally, the UCI only announced their decision on the matter right before the second Time Trial. They did not provide further insides in the decision making process and with the long decision time they provided the room for speculation and discussion from other actors. The LZR Racer was also already approved by FINA but because of complaints they re-evaluated the swimsuit. They concluded there was no evidence for the alleged buoyancy of the swimsuits but it also became clear FINA had no real tests to determine buoyancy. Later on, FINA published a list of approved swimsuits and not much later they updated this list approving suits they previously banned, showing the uncertainty and inconsequence of their decisions. Furthermore, despite collaborations and negotiations with different stakeholders such as coaches and manufacturers these it was unclear why and on what grounds these decisions were made. These actions decreased their formal authority and many stakeholders blamed the FINA for the chaos and letting the situation come this far.

Furthermore, in all cases the expectations that the governance unit should rule was expressed by different actors. In the Skeleton case, the Latvian coach claimed the IBSF should rule but was weak challenging it's formal authority. In the Cycling case Fred Grappe also called on the Tour Commissaries and the UCI to rule to prevent all kinds of aerodynamic additions and in the Swimming case FINA was called upon on multiple occasions to prevent things from getting out of hand and to ensure a fair introduction of new equipment. This shows that action from is expected to provide settlement regarding new equipment. But when governance units ruled this was not always accepted and their formal authority was challenged. This was however caused by governance units themselves by leaving room for rule ambiguity and providing the opportunity for contention.

4.5.5 Settlement

Settlement differed per case. In the Skeleton case no real settlement could be distinguished. In the end the suits were still legitimate for some the introducers and not the opponents. However, the suit has not been used in competition since then. In the Cycling and the Swimming case multiple moments of settlement could be distinguished. In the Cycling case settlement was reached by the governance unit stating the suits were approved for use. Contention stopped but later rule changes were made. Possibly to prevent similar future contention. In the Swimming case settlement was more twofold. Legitimacy of the suits was low among users and there was a clear wish in the field for regulatory settlement but FINA was slow in implementing this. So real settlement only took place when the suits were already no longer seen as legitimate.

5 DISCUSSION

This section elaborates on the conclusions that can be drawn from this research. These findings will be discussed following both an innovation theory as institutional theory perspective. Drawing from those conclusions and discussions contributions on the interface of innovation studies and institutional theory and most importantly the interaction between them are made. This research aimed to answer the research question; *How do strategic actions by users, producers and institutional actors influence the legitimization of performance-enhancing equipment in elite sports?* To answer the research question five analytical steps were undertaken. First, a timeline was drafted to provide insights in the course of the controversy based on the phases defined in SAF theory by (Fligstein & McAdam, 2011). Second, the relevant institutional actors and their roles were identified based on SAF theory. Third, the eventual outcome of legitimacy was discussed and scored based on three pillars of legitimacy by Suchman (1995). Following, the different strategies employed by the institutional actors influencing this legitimacy were identified based on the framework by Pelzer et al. (2019). Lastly, all cases were compared based on the preceding analysis. This section first discusses the innovation and institutional perspectives individually and eventually these are combined in an overall process model regarding legitimization for innovations in elite sport.

Innovation perspective

When looking from a technological innovation perspective this research provided multiple insights on the legitimization of performance enhancing equipment in elite sports. First of all, the analysis showed that in all cases onset of contention happened when the innovations were publicly visible, either through media attention or in race context, combined with successful performances of its users. Therefore, it seems success and visibility of the innovation are a necessary condition for the start of contention. Gelberg (1998) does hint at the conditionality of success for contention by describing successful use of technological innovations cause controversy but does not make this explicit. In this research the mechanisms underlying the onset of contention; identification of threat or opportunity and the acting on this threat or opportunity were operationalized as the development and introduction of the skinsuit. This assumed that the introduction of the suit was the strategic action that triggered contention. In hindsight the onset of contention can better be operationalized as the moment the innovation was noticed by other actors, resulting from its visibility and success instead, of the introduction of the suit. For example, in the Cycling case, Team Sky used a silent introduction strategy and did not cause contention the first time the suits were used. The visibility of the suits was more accidental since the rain made the vortex balls show in the white jerseys. This is in contrast to the Swimming case where Speedo publicly introduced the suits at a big marketing event to positively frame the suits and strategically increase its visibility. In this case contention quickly followed.

Secondly, the cases showed the introduction of the new skinsuits was done through a user-producer interaction of at least two dominant actors who aimed to keep their dominant position in the field. In the Swimming case it was also seen that Speedo was a dominant producer, while in the Skeleton and Cycling case the producers were only dominant based on their relation with a dominant user. SAF theory does acknowledge that dominant actors engage in strategic actions to keep their dominant position. However, it does assume strategic actions from dominant actors are generally accepted within field rules. So it is interesting to see that in these cases the dominant logic and field rules were challenged by a technological innovation developed by

dominant actors and not by challengers. Furthermore, contestation of these technological innovations did not only come from challengers but also from other dominant actors, while SAF theory assumes contestation is an interaction between challengers against the dominant field logic and thus dominant actors. In these cases dominant actors had different interpretations of field rules and therefore contention between these actors also occurred.

In innovation studies user-producer interactions have been discussed extensively and have shown to be a fundamental source of technological advances (Malerba & Orsenigo, 2010). Research focusing on user-producer interactions in sports showed the institutionalization of these interactions for equipment innovations by showing how users were actively involved in the innovation process in multiple extreme sport fields (Grabher et al., 2009; Lüthje, 2004; Shah, 2000). These studies took a user-perspective focusing on user-driven innovations and how lead users sought interactions with producers for further development and manufacturing of their innovations. Gerke (2016) states only few studies focus on product innovation in sport equipment manufacturers and distributors and how they interact with other actors. These studies only focussed on equipment intensive action sports such as snowboarding, sailing and windsurfing and do not focus on equipment specifically developed for elite divisions of these sports (Desbordes, 2002; Gerke, 2016; Grabher et al., 2009; Hillairet et al., 2009; Lüthje, 2004; Shah, 2000). Bråtå et al. (2009) studied user-producer interactions from a producer-perspective and defined different user groups relevant for producers. They state professional and sponsored athlete often develop close reactive relations with producers. They are not actively involved in user innovations but producers use them for testing and promoting new technological innovations in sport (Bråtå et al., 2009). In the researched cases similar interactions as described by Bråtå et al. (2009) were seen between athletes and producers.

A field level condition not discussed in the context of sport, but identified in this research is the form of 'exclusivity' of the user-producer interaction. The three cases showed a difference in exclusivity of the innovations resulting from these user-producer interactions. In the Swimming case the degree of exclusivity was formally institutionalized by FINA by dictating all suits had to be available to all athletes, limiting the possibilities for fully exclusive user-producer relations. This form of exclusivity was responsible for a different dynamic during contention. First of all, it caused other producers to engage in strategic action during contention which was not seen in the other two cases. For example, in the Swimming case producers actively engaged in framing their suits by media introductions and promoting their suits during competitions. Furthermore, producers were actively involved in collaborations with the FINA regarding new regulations and improved assessments. Additionally, because in this case users and producers did not have a fully exclusive relation, the position of producers in the field were not defined by the position of their users as in the Cycling and Skeleton case. The possibility of users to switch suits based on their preferences at that moment also shifted producers positions in the field during contention. Literature on the exclusivity of user-producer interactions also showed producers who are able to establish relations with more than one user have a high probability of becoming dominant in the field (Malerba & Orsenigo, 2010), as can be seen with Speedo. However, as discussed in the context of sport it is unclear how this exclusivity impacts the innovation process.

Thirdly, in all cases cognitive legitimacy showed to be important for the eventual settlement which fits with the notion of Suchman (1995) who states that cognitive legitimacy provides the strongest basis for overall legitimacy. In Cycling, innovations in equipment and improving

aerodynamics are common practice, especially in Time Trials and were therefore accepted. This was the same for Skeleton since innovation and equipment was seen as key in a sport where equipment is a precondition for practice of the sport. In the Swimming case, this role of technology and innovation posed a bigger problem. Swimming was always seen as a pure sport where equipment did not play a role and the use of the LZR Racer and its successors challenged that. So the use of the LZR Racer and the eventual impact it made on swimming as a whole did not fit with cognitive ideas on what swimming should be. This cognitive evaluation did not only result in the delegitimization of one particular suit or type of suit but delegitimized the whole innovation process on full-body swimsuits.

Kaplan & Tripsas (2008) also describe that cognitive dynamics influence technological life cycles and emphasize the impact of institutional actors such as governance units in steering these trajectories. This research defined the skinsuits as new technologies but analysis showed that the innovation processes regarding these suits had been ongoing for a longer period of time and the suits were continuations of previously used technologies. Why these specific suits caused contention can be explained by the fact that trajectories of new technologies are uncertain *ex ante*, meaning when new technology trajectories start it is difficult to predict what they will bring in the future (Kaplan & Tripsas, 2008). An illustrative example is given by the case of the Prince tennis Racket discussed in the theory section. The first versions of this rackets only minimally impacted performance, so the governance unit did not intervene allowing them to become the most popular rackets. Later refinements of the racket revolutionized the elite competition, but since earlier versions were accepted, it was difficult to ban afterwards (Gelberg, 1998). In the Swimming case a similar process is seen where first full-body suits provided an acceptable influence on performance, by allowing these suits innovation processes could continue. The use of the LZR Racer eventually challenged the cognitive ideas on swimming because of its major impact on performance. By also allowing the use of the LZR Racer, FINA caused the innovation processes to further intensify, as other producers rushed to develop their own versions. Following, FINA struggled to appropriately react to these suits but in contrast to the tennis rackets, FINA did eventually implement new regulations, discontinuing the innovation process completely. This is remarkable since Kaplan & Tripsas (2008) only define new better technologies to be a source of discontinuity of technological life cycles, not governance unit interventions as seen in the Swimming case.

In Skeleton and Cycling this discontinuity of the innovation process was not seen. In Cycling new regulations eventually banned the Vortex suit but as explained the innovation process reducing aerodynamic impact was still ongoing. Team Sky and Castelli themselves did discontinue the innovation process regarding the Vortex dimples, pursuing new innovations to reduce aerodynamics such as skin-tight fabrics, which follows the process model of discontinuing innovation by newer technologies described by Kaplan & Tripsas (2008). However, other producers, such as Bioracer and Endura did continue innovations regarding aerodynamic additions. In Skeleton, where settlement was undefined it remains to be seen whether Team GB will use similar suits or will bring something new for the next Olympic.

In the Skeleton and Cycling case, the innovation processes and relevant actors in these processes were very similar. Both suits were developed using wind-tunnel testing and 3D-computer modeling for testing and individually fitting of the suits. Furthermore, UK Sports, was responsible for the development of the technology used in both suits. UK sports developed the aerodynamic additions for Track Cycling in 2012 together with TotalSim and Sir Dave Brailsford

brought this technology to Team Sky, by being both former performance director of the UK cycling team, part of UK sports and performance director of Team Sky. Dave Brailsford can be seen here as an institutional entrepreneur introducing the new practice in the field of Road Cycling. UK Sports further developed the technology for their Skeleton athletes to use in the 2018 Olympics. In this research all fields were viewed individually and in isolation without taking relations to other fields into account. SAF theory describes that changes in one particular SAF can spillover to other proximate fields. Fligstein & McAdam (2011) do not explicitly describe technological innovations to spillover but in innovation literature these spillovers are commonly acknowledged (Verspagen & De Loo, 1999). The Cycling and Skeleton case also showed technological innovations to spillover from Track Cycling to Road Cycling and Skeleton.

As mentioned in the introduction Fligstein & McAdam (2011) mostly focus on the emergence of new fields or fields in crisis destabilized by external shocks originating from other SAFs, actions of the state, entrance of other groups of organizations or large scale crises such as wars or depressions. Just as they did not account for technological spillover they also did not acknowledge technological innovations as a possible source for field crisis. In innovation literature ability of technologies to destabilize fields is more commonly acknowledged (Fuenfschilling & Truffer, 2016). This research also shows that technological innovations from within the SAF are capable of destabilizing a field and redefining the rules of the game as demonstrated in the Swimming case. Furthermore, Fligstein & McAdam (2011) explain contentions do not necessarily lead to destabilization of fields but that all fields are contentious in nature and overtime they move back and forth on a continuum as crises challenge current field structures and fields become re-established. In the Skeleton and Cycling case, contention did not destabilize the field as in the Swimming case but these contentions can be seen as part of this moving back and forth on its field's continuum.

As SAF theory describes, SAFs can be seen as Russian dolls were one SAF consist of multiple smaller SAFs and one single SAF is always part of a bigger SAF (Fligstein & McAdam, 2011). This Russian doll principle implies a fractal pattern where processes on different field levels follow similar structures. When looking at the course of the legitimization processes in these cases, the difference was mostly seen in the depth of discussions but the closely relating to the timelines of the cases. The similarities in the innovation process is already discussed for Cycling and Skeleton but Swimming also showed a similar goal and structure for their innovation process but their focus laid on aqua- instead of aerodynamics. These three fields can therefore also be looked into as part of a larger SAF regarding 'equipment sports'. The episodes of contention discussed in this research can then be seen as pivoting around a continuum in the field of 'equipment sports' regarding the role of technological innovations. This shows this theory can be used on multiple levels and similar dynamics can be expected for smaller and bigger fields, just on another scale. However, Swimming actively broke with this field by discontinuing the innovation process and moving away from technological equipment innovations.

Institutional perspective

This research also provides insights in the legitimization process of performance enhancing equipment in elite sports when approached from an institutional perspective. An important aspect of this institutional perspective are the governance units in the different fields. Strategic actions by these governance units showed to impact legitimization, either by facilitating settlement or by leaving room for rule ambiguity and contention. SAF theory defines governance units as actors who facilitate the functioning of the system and ensure compliance with field rules (Fligstein & McAdam, 2011). Fligstein & McAdam (2011) describe governance units to be

conservative and to safeguard the interests of dominant actors assuming a passive role. In all three cases governance units did follow the dominant users and producers but they also actively engaged in strategic actions, which is not operationalized in SAF theory. Because governance units follow the dominant logic they are not neutral arbiters in conflicts between challengers and dominant actors. This however mismatched with expectations other actors had of these governance units. Most actors expected governance units to occupy this neutral position and rule in times of contention.

The right for governance units to make these type of decisions can be referred to as its formal authority (Battilana et al., 2009; Fligstein & McAdam, 2011; Phillips et al., 2000). Formal authority can be described as 'an actor's legitimately recognized right to make decisions' (Phillips et al., 2000, p.33). One flaw in SAF theory is that this formal authority is exclusively given to state actors. Phillips et al. (2000) states this formal authority can be possessed by all type actors in the field and more dominant actors mostly possess more formal authority. Vamplew (2007) describes that sport authorities are expected to decide whether new equipment technologies are legitimate or not, based on regulatory structures and Dyer (2015) & Gelberg (1998) state that the lack of governance unit action in deciding whether new equipment is legitimate enabled contention. This shows that, at least in sports, governance units possess this formal authority to a certain degree. Adding this understanding of formal authority to governance unit operationalization provides a better understanding of their role and position within a SAF. This means governance units are not only responsible for the smooth functioning of the system and to ensure compliance to field rules (Fligstein & McAdam, 2011) but they also possess the formal authority to do so. This formal authority also provides a less static operationalization of governance units in that this formal authority can be questioned and governance units can be challenged during episodes of contention as also can be seen in the cases. However, despite governance unit validating the technologies contention remained and governance unit decisions were questioned. This is for example seen in the Swimming case where formal authority of the FINA was challenged and a dominant actor, most notably Team US, used their own formal authority to try and enforce settlement.

As described, governance units are expected to decide whether the use new technologies is legitimate based on regulations. In the Cycling and Swimming case it became clear that the regulations were not adequate to assess the legitimacy of the use of these new technologies. Gelberg (1998) already described that it is impossible for authorities to provide an all-encompassing regulatory framework and to anticipate all possible innovations and their consequences (Gelberg, 1998). The results of this research and the concept of field proximity from SAF theory however imply that it might be possible to anticipate on new technologies in sport. First of all, technological innovations showed to spillover from proximate fields, specifically Track Cycling to Road Cycling and Skeleton. Secondly, the innovation process on minimizing aero-, and aquadynamic impact of skinsuits had been going on for a longer period of time. Thirdly, rule ambiguities were present in each case and in Cycling and Skeleton this had already led to problems in the past. This shows that governance units should have been able to anticipate on future developments. In turn governance units could have prevented contention by keeping a more prospective outlook on innovations and translating this to formal rules and regulations with minimal room for ambiguity.

From this research it remains however unclear if governance units really lacked the capability of anticipating on new technologies or that they simply did not act on this. As technological innovations were mostly seen as desired and as progress for the sport by governance units it

could be the case that they intentionally left these ambiguities unresolved. Governance units can deliberately use ambiguities in a strategic way to seek creative engagement or compliance of stakeholders (Davenport & Leitch, 2005). Rule ambiguities can be used by interest-driven actors to stretch rule interpretations (Hoekman & Boon, 2019), which was also seen in the researched cases where rules were interpreted in a way that provided room for innovation. Mahoney & Thelen (2009) also emphasize that ambiguity leaves room for creativity and agency but they also state ambiguity is permanent in that it can never be prevented fully. Fischer & Miller (2006) do discuss that ambiguity can be resolved through social learning as a process where shared understandings are formed around an artefact. They also point out to the involvement of scientific experts to enable social learning, which also showed in the Swimming case. Rip (1986) provides a similar perspective and applies this social learning to controversies. He introduces the concept of controversies as informal technology assessments based on social learning. He states controversies provide conflicting assessments of technologies which are further articulated and settled during the course of that controversy. He acknowledges the role of actor strategies and interactions based not only on scientific evidence but also on actors interests on the eventual settlement of controversies (Rip, 1986), as also discussed in SAF theory. Further work in Science and Technology Studies show controversies can therefore fulfill the role of technology assessments by pointing out potential problems that need to be considered for implementation of these technologies (Mohr & Raman, 2013). It is possible governance units strategically used a wait-and-see approach to let these social learning processes unfold. It is however important to note that this informal technology assessment and contention also provides room to question and challenge governance units formal authority as seen in all cases.

Despite whether governance units in the Cycling and Swimming cases intentionally left rule ambiguities exist or refrained from intervening to trigger an informal technology assessment, this informal assessment did take place. In the described cases however this process was not before implementing new technologies but coincided with usage of the technologies within competition. With their new regulations FINA already prevented this for the future by demanding new swimsuits have to be approved one year before the Olympics and commercially available 6 months in advance. In the other two cases however secrecy of development was more important and technologies were only revealed during competition which is also possible due to the aforementioned difference in exclusivity. But for sports governance units who actively want to pursue more informal ways of assessing new technologies such regulations could be beneficial.

Process model

Combining the insights from both the innovation and institutional perspective provides a better understanding of the legitimization process of technological innovations in elite sports. This research proposes a model to add to this understanding based on the previously discussed findings which are on the interface of innovation studies and institutional theory and most importantly the interaction between these. This model further integrates the concepts of user-producer interactions, visibility and success and technological discontinuities from the technological innovation perspective and technology assessments, ambiguity and formal authority from the institutional perspective with SAF theory. Figure 10 depicts this process model schematically.

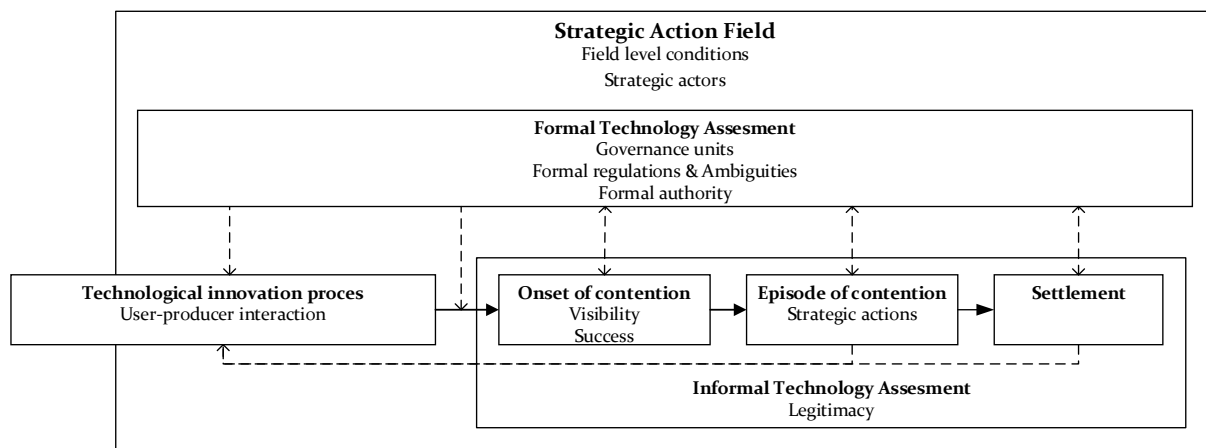


Figure 10 Proposed process model for legitimization of innovations in elite sports

This proposed model adds to the used conceptual model, shown in Figure 1, on multiple aspects. First of all, it adds to the understanding of the phases of contention described in SAF theory. The mechanisms for the onset of contention are operationalized differently in this model than in the used conceptual model. This research assumed the introduction of new technologies would trigger the onset of contention, however, analysis showed that this is triggered by the visibility and success of the innovation. Silent introductions or introducing the suit right before competition could be seen as a strategy to reduce visibility and postpone contention to after the suits have already been used.

During the episode of contention, actors were seen to engage in different strategic actions to influence the pragmatic, moral and cognitive legitimacy of the technology. The framework of institutional strategies by Pelzer et al. (2019) proved sufficient to understand strategic actions from dominant actors and challengers. The conceptualization of legitimacy by Suchman, (1995) provided the tooling to understand and analyse the legitimacy of the new technologies but also on the field level evaluation criteria relevant during contention. This conceptualization proved useful in this context and is therefore included in the proposed model but other conceptualizations for example by Binz et al. (2016) or Scott (2001) could also be used in this or other contexts.

Most importantly this model incorporates the technological innovation process to show how technological developments can trigger processes of contention and how contentions feed back into this innovation process. The interaction between these innovation process and institutions were shown in this research on multiple levels.

Governance units play a crucial role in this interaction. As described, SAF theory and the strategic actions defined by Pelzer et al. (2019), were not sufficient to understand governance unit actions and influence. The proposed model provides room for this more active role of governance units in influencing both contention and innovation processes in multiple ways. Starting, governance units steer the innovation process by setting formal rules and regulations which determine the context in which innovations can be developed and introduced. Furthermore, within those regulations rule ambiguities are likely to be present and provide room for creativity and rule stretching by producers in the field. When new technologies are introduced, governance units are expected to asses these technologies based on their regulatory structures. But because of these rule ambiguities some new technologies remain difficult to assess and can lead to contention. This model adds the concept of informal technology assessment as a process during contention to better understand how contention can be seen as

a social learning activity based on cognitive evaluations leading to settlement accepted by all field actors. Cognitive legitimacy and evaluations proved to be most influential for the overall legitimacy of the technologies. During contention this informal technology assessment parallels formal technology assessments by governance units and these two processes influence each other through the strategic actions of governance units, and dominant and challenger actors.

Furthermore, both technology assessments influence the innovation process. By accepting the use of certain technologies, the innovation process regarding these technologies can continue and sometimes even intensify. Settlements can leave the door open for the continuation of the innovation process but can also lead to the discontinuation of the innovation process completely.

How the strategic actions eventually lead to settlement can be explained by the formal authority of different actors. Actors having a high degree of this formal authority can enforce settlements. Within sports fields governance units generally possess a high degree of formal authority and can therefore enforce settlements through regulatory decisions. This research also showed this formal authority of the different actors, including of governance units can shift during contention based on their strategic actions and how these are interpreted in the field.

Limitations and future research

Although this research specifically focused on sport, the theoretical concepts are more widely used in innovation studies, suggesting this model could possibly be translated to other fields as well. The strength of the SAF model is that it can be applied to multiple field and field levels because of its fractal pattern. However, the additions done in this research do specify the model to technological controversies making it less generally applicable. Furthermore, as expected external state actors were not identified to be actively engaged during contention in the case of sport, governance units had high formal authority and external state actors were not identified to be actively engaged during contention. It is therefore questionable how this model holds up in fields where formal authority is more evenly distributed among field actors and/or fields where state actors have a bigger influence.

To further develop and test this model different directions of research are necessary. First of all, research taking a more quantitative approach could test whether visibility and success of innovations in sports are conditional for the onset of contention. Additionally, it would be interesting to further elaborate on the field-level condition 'exclusivity' for sport equipment by including more sports fields with different degrees of exclusivity. This research showed that it influenced the dynamics of contention by putting producers more in the forefront in contention. However, it remains unclear how this influences formal authority dynamics and eventual settlement.

Due to the usage of news articles as the primary source of data and the lack of interviews, this research was not able to provide insights in what happened behind the scenes during the technology evaluations by governance units. Only the outcomes of these evaluations that went public were included in the data. This poses the biggest limitation of this research, since it remains unclear why these governance units made certain decisions and engaged in certain actions. Therefore, the question whether governance units want to prevent rule ambiguities and controversies remains. Future research could provide more insights in governance unit strategies regarding ambiguity, technology assessments and enforcing settlements. By conducting in depth interviews with governance unit actors, data on backstage governance unit actions can be collected to analyze governance unit strategies.

Another limitation of this research that could be addressed in future research is that fields were looked at in isolation while SAF also describes influences of proximate fields. This research did show field interactions on the innovation level. As shown in the proposed model, the innovation process exceeds field borders implying other fields influence this process. In the swimming case, the innovation process was more internal to the field than in the Skeleton and Cycling case. In the Swimming case, settlement directly linked to the innovation process since settlement did not only delegitimize the specific technology but also the whole innovation process. This indicates that governance units possibly have more influence on the innovation process when this is more internal to the field instead of spread over multiple fields. Future research could look into how proximate fields not only influence the innovation process but also how this effects the governance of these innovations and processes.

Despite these limitations this research has provided more insights in the legitimization process of performance enhancing equipment and has contributed to the theoretical understanding of controversies in sports by integrating multiple theoretical frameworks and proposing different avenues for future research.

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APPENDIX A

SKELETON

Actor role	Actors	User/Producer	Justification
Governance unit	IBSF		<ul style="list-style-type: none"> ○ The international federation for skeleton ○ Responsible for drafting, interpreting and enforcing regulations
	International Olympic Committee (IOC)		Governance unit of the Olympics in general
Dominant actors	Team GB skeleton	Specific user	<ul style="list-style-type: none"> ○ Britons invented Skeleton in the 19th Century ○ Only country to have won a medal every time the discipline has featured in the Olympics. ○ Two of British athletes were favourites for gold in the women's competition for the 2008 Olympics. ○ Team GB athletes were reported wearing the suits
	Team US	General user	Katie Uhlaender was a former world champion and all competing athletes wore skinsuits
Challengers	Rival nations	General user	No other countries were mentioned to be dominant in the field and all competing athletes wore skinsuits
Introducers	UK Sports, English Institute of Sport, Total Sim & British Cycling	Producer	TotalSim in collaboration with British Cycling developed the IP for the suits which spilled over to Skeleton via the British Institute of Sport. UK Sports Introduced a new type of skinsuit for Team GB's athletes causing the contention
Opponents	Team US	General user	<ul style="list-style-type: none"> ○ Multiple reports claim rival nations and athletes question suits, without further specification of these nations
	Katie Uhleander Latvian Coach 'Rival nations'	General user	<ul style="list-style-type: none"> ○ Notably US with Katie Uhlaender questioning legality ○ Latvian Coach comments on suits

ROAD CYCLING

Actor role	Actors	User/Producer	Justification
Governance unit	Race Jury/ Race commissaires		Official jury of the Tour the France, checked and cleared the suits for use.
	Union Cycliste Internationale (UCI)		<ul style="list-style-type: none"> ○ Official union for international cycling ○ Responsible for drafting, interpretating and enforcing regulations
Dominant actors	Team Sky Chris Froome Geraint Thomas Sir Dave Brailsford	Specific user	<ul style="list-style-type: none"> ○ Dominated the Tour in recent years ○ By far the highest budget (35 million euros while number two and three have 20 and 14,5 million respectively) ○ Dominant in results but a have a bad reputation because of drug allegations and other controversies ○ Team Sky wore the Vortex skinsuit in the Time Trials in the 2017 season.
	Castelli & British Cycling	Specific producer	Castelli produced the skinsuits for Team Sky using knowledge from British Cycling
Challengers	Movistar	Specific user	Movistar reported wearing a skinsuit using similar technology in their Time Trials skinsuits.
	FDJ Fred Grappe	General user	Competing cycling team making use of skinsuits during Time Trials
	BMC	General user	Competing cycling team making use of skinsuits during Time Trials
	Endura Bioracer	Specific producer General producer	Endura produced the skinsuits worn by Movistar Bioracer also appeared in the data as producer, more prominent in the 2018 season.
Introducers	Team Sky	Specific user	Introduced a new skinsuit for their athletes causing the contention.
Opponents	FDJ	General user	Both teams made complaints about the suits to the race jury. Fred Grappe publicly questioned the legality of the suits and continued allegations even after clearance of the race jury.
	BMC	General user	

SWIMMING

Actor role	Actors	User/Producer	Justification
Governance unit	Fédération International De Natation National swimming federations		International federation of swimming responsible for drafting, interpreting and enforcing regulations. National federations enforcing rules nationally independently from FINA, for example banning suits accepted by FINA in national Olympic Trials or junior competitions.
Dominant actors	Team US Michael Phelps Team Australia Speedo	Specific user* Specific user* Specific producer	Michael Phelps most successful international swimmer. Furthermore, both Team US as Australia were referred to as swimming powerhouses and have successful Olympic athletes. <ul style="list-style-type: none"> ○ Introduced the LZR Racer. ○ Put millions in development of skinsuit working with NASA and universities. ○ Major sponsor of FINA ○ Sponsors Team USA and Australia, personal sponsor of Phelps ○ Worn by majority of previous Olympic games medallists
Challengers	Arena, Adidas, Jaked, Bluseventy & Nike Other competing countries	General producers Both general and Specific users*	Actors reported to produce swimsuits, some also active in developing LZR imitations and successors. Some competing countries wore the LZR racer others wore suits from other manufacturers.
Introducers	Speedo	Specific producer	Speedo developed and introduced the LZR Racer.
Opponents	Arena TYR Dutch Team Jacco Verhaeren Team Canada Team France Team Italy	General producer General producer Specific user* Specific user* General user* General user*	Swimsuit producer who asked for proper analysis of the LZR Racer. Swimsuit producer who sued Speedo for the LZR Racer A contender of the LZR racer from the beginning, calling for better regulations and a level playing field. The Dutch Team did wear the LZR Racer Head Coach called for a halt on new swimsuit technology and banned the suits for national Olympic trials. athletes did wear the LZR Racer Head Coach called for a debate on the impact of the LZR Racer. France was sponsored by Arena Conducted an in depth study on the impact of the suit to prove it's unfairness, Head Coach called the LZR technical doping. Italy was sponsored by Arena
Other	Scientific experts		Were active in the discussion and involved by other actors for advice

*Individual athletes of the teams could have worn other suits based on personal sponsor agreements or preferences