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Instant Replay in the National Football League

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Repository Citation

Tingle, J., & Armenteros, M. (2020). Instant replay in the National Football League. In M. Armenteros, A. J. Benitez, & M. Á. Betancor (Eds.), *The use of video technologies in refereeing football and other sports* (pp. 164-180). Routledge. doi: 10.4324/9780429455551-9

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1 **Instant Replay in the National Football League**

2 Jacob Tingle

3 Manuel Armenteros

4 **Abstract**

5 In this chapter the introduction of the Instant Replay video system in the National Football
6 League (NFL) is analysed. The league started experimenting with video technology in
7 1986, which means its had more than 30 years of experience with a system similar to that
8 approved by IFAB and FIFA in 2016. Although these are different sports, in this work
9 the advent of technology and the evolution in NFL Instant Replay rules can be a roadmap
10 in football. The role of the referee and the communication between coaches, referees, and
11 TV now being discussed in football, has a long trajectory in the NFL. The NFL and its
12 TV broadcasters have worked to find synergies to adapt league rules with the aim of
13 improving the fan experience. However, despite its long implementation period and
14 numerous incorrect real-time decisions overturned, there remain important voices
15 proposing that Instant Replay should be limited, or even eliminated.

17 **Keywords**

18 NFL, instant replay, video technology, football,

20 **Introduction**

21 American football began in the 19th century with contests between college and university
22 teams and is one of the most popular sports in United States (U.S.), with over 17 million
23 fans attending games during the 2017 season (Lukas, 2018). The National Football
24 League (Profootball, 2017) was founded in 1920 and at present 32 team play 16 games
25 (for a total of 256 games) during a 17-week period.

26 Each team participates with 11 players, has one head coach, and an average of 15 assistant
27 coaches. The game lasts four 15-minute quarters and each team is allowed to have 53
28 players on its active roster. Of these 53, only 46 players can dress out for the actual game.

29 When NFL was founded in 1920, it was modeled after the collegiate game for its first 12
30 years. In 1932, the NFL broke ranks on a few rules and appointed its own Rules
31 Committee, charged with developing independence from the colleges and increased the
32 number of officials to better ensure compliance and fair play.

33 To be considered for a position as an NFL official, candidates must have a minimum of
34 10 years experience officiating football, at least five of which must have been at a varsity
35 collegiate or another professional level. The candidate must be in excellent physical
36 condition (Alder, 2017). For their efforts, officials can earn between \$4,000 and \$10,000
37 a game depending upon their experience and the number of playoff games they work
38 (CBS, 2014).

39 Instant replay was first used on December 7, 1963, during the popular “Army-Navy
40 game” between the U.S. Military Academy and U.S Naval Academy. Thanks to the
41 innovation of a 29-year-old CBS TV producer Tony Verna, football the world of
42 American football was changes forever (Verna, 2008).

43 In 1976, Art McNally, then the NFL director of officiating and previously as a field judge
44 and referee, wanted to explore how long a video review would delay a game. (NFL,
45 2018b). Equipped with a stopwatch and a video camera, he observed the Dallas Cowboys
46 versus Buffalo Bills game from the press box, and he saw a missed call involving O.J.
47 Simpson that could have been corrected. At that moment, he knew replay would benefit
48 the league, its teams, players, and fans.

49 At its inception in 1986, video tapes and analogue linear systems were used to move
50 forward and backward in the search for replays. Since then, the NFL has experimented
51 systems to help referees correct mistakes that have “indisputable visual evidence” (NFL,
52 2018b).

53 As a result of the technological developments, NFL officials use the same NFL broadcast
54 camera feeds and the system allows immediate labelling and recovery of plays in a non-
55 linear way. Doing so allows officials to make rulings in the allotted 90.

56 However, despite having a wide range of cameras and a fast replay system, NFL
57 officiating continues creating controversy and there are many important voices concerned
58 about the system. Some of which propose to eliminate it.

59 Why does the use of a video replay system that has been supporting officials for more
60 than 30 years continue creating controversy? Is it a technological problem? Is it due to an
61 immature technology? Is it due to the lack of referees’ education? Or can it be simply as
62 a consequence of the complexity of the NFL rules?

63 How are replay decisions between the referee and teams communicated? How many times
64 replay can be used? Is there a limit? In what cases? The understanding of how replay
65 works and the challenges that the officiating department had to deal with, can help
66 football to anticipate some of the challenges that FIFA and the IFAB should expect.

67

68 Technological implementation in the NFL

69 The NFL is a league that takes advantage of the existing technology and an early adopter
70 for technological deployment, both in the player development and in the support its
71 officials.

72 Zieglemeir (2017) studied the different technologies used by football stakeholders. The
73 coaching staff use free action cameras, such as the GoPro, that allow them to analyse the
74 players angle of view and the position of their players as well as individual advice to
75 perform their play. Other advances in virtual reality such as Google or Oculus virtual
76 glasses, are used to provide players a virtual training scenario in 360 degrees.

77 To monitor the physical and tactical performance, NFL coaches use the "Adidas miCoach
78 Elite Team System", which provides player physical training data such as speed, distance
79 covered, and heart rate.

80 The NFL has evolved since its inception in ways that help officials “get calls right.”
81 As such, replay is a natural development in the evolutionary process. When the NFL
82 began as the first organized professional football league in 1920, only three officials
83 (referee, umpire, and head linesman) were allowed. The field judge was added in 1929
84 and the back judge in 1947. In response to scrambling quarterbacks, and in particular to
85 tactics of players like Fran Tarkenton, the line judge was added in 1965 to watch the
86 opposite side of the line of scrimmage. The side judge was added for 1978, when the NFL
87 implemented new rules to open up the passing game (Austro, 1965).

88 When the games were first regularly televised in the late 1940s, NFL officials felt the
89 fans had an advantage because those in attendance could observe the replays on stadium
90 video boards. Everyone but the referee knew what happened on the previous play. In 1975
91 referees were also equipped with wireless microphones and had the obligation to explain
92 on-field rulings to a much wider audience.

93 “Beyond the entertainment value, the ability for fans to hear the calls added
94 credibility to on-field rulings, increased transparency on rulings for fans and the
95 media, and reinforced the integrity of the game” (NFL, 2018a, para. 28).

96 *Without a doubt*, TV increased the popularity of the game and enhanced demand from
97 officials to make decisions concessions in order to satisfy fans. Conversely, increased TV
98 presence afforded officials with an important and useful tool: Instant Replay.

99 **First instant replay experiments**

100 **Experimentation with** Instant Replay began in 1976 (NFL, 2018a). McNally, NFL
101 supervisor of officials and key people in the Officiating Department’s transformation,
102 tested how long a video review would delay a game. McNally also conducted a survey to
103 know the opinion of teams. They had to grade each foul call on a seven-point scale, from
104 poor (1) to excellent (7).

105 In 1978, the league tested Instant Replay during seven nationally televised preseason
106 games. During that trial, calls remained inconclusive after lengthy reviews; McNally
107 realized that they needed more cameras than broadcasters used for games and. After that
108 first game, Assistant Supervisor of Officials Nick Skorich said:

109 “We still think we need a minimum of 12 cameras to get all the angles on every play,
110 (...)Electronically, I don’t know if we are advanced enough yet”(NFL, 2018b).

111 In 1985 clubs voted to test a review system during eight preseason games. There was no
112 unanimity in the vote. Four clubs voted against instant replay, but the 23 votes was more
113 than the 21 votes needed to use the instant replay in the upcoming year. Also, a new vote
114 would be need during the following offseason. Cleveland Browns owner, Art Modell,
115 said after the vote: “[Owners] didn’t want a playoff game decided by a bad call, and so
116 they tried to push it through right there.”(NFL, 2018b).

117 On September 7th, 1986, instant replay was used for the first time in an NFL regular-
118 season game. That first season saw an average of 1.6 reviews per game for a total of 374
119 plays; only 10 percent of which reversed the ruling on the field (Soundavision, 2017).

120 The NFL Director of Administration, Joe Rhein said that “it’s possible to review instant
121 replays and get the word to the referee on the field without a significant loss of
122 time”(NFL, 2018b), but even that lost time was significant enough to make the game
123 longer and slowed the tempo.

124 At its inception, cameras were less sophisticated than they are now, and relatively few
125 were employed, meaning replay officials often did not get a definitive look at the play.
126 The technology was not very refined and sometimes the field referee misunderstood the
127 message, in one example the referee heard “Pass is complete” instead of “Pass
128 incomplete” (Goodwin, 1986). Because of these mistakes, the league was forced to
129 replace its walkie-talkies with pagers and radio headsets and it changed the terminology
130 using clear terms like “confirmed” or “reversed” (NFL, 2018b).

131 In a survey conducted by CBS nearly 45 percent of the 175,000 people who voted,
132 indicated they thought replay should remain, but with changes. Another 29 percent said
133 they favored the rule as it is, while 26 percent said they opposed the rule (Goodwin, 1986).

134 A replay official monitored the live game feed from an in-stadium booth, and initiated all
135 reviews, reversing a call only with “indisputable visual evidence.” When there was a
136 question about a call, the official replayed the telecast on one of his machines as the head
137 field official was alerted to halt play. The other Video Cassette Recorder (VCR) continued
138 recording the telecast so the official could study any other replay angles shown.

139 Expressing the unknown nature of the replay booth official, Dennis Lewin, the head of
140 production for ABC Sports said, "We have no clue about how long he'll wait, or what he's
141 waiting to see" (Goodwin, 1986). Both the networks and the league emphasized that the
142 official did not dictate which replay angle he wanted to see or what order they were shown
143 in. Nor may he requested any particular shot. He merely saw what was broadcasted,
144 replayed what he wanted on his tape machines, made his call, and relayed it to the field.

145 Some executives were also concerns because the dependence on the NFL to provide
146 pictures to settle questionable calls brought with it the potential that the outcome of games
147 could be influenced directly by the producers who decide where cameras were focused,
148 which ones were attached to replay equipment, which replay angles were selected chosen
149 for airing, and in what sequence (Goodwin, 1986).

150 To address that concern, television executives asked NFL to get its own equipment and
151 highlighted that they had no problem with the theory of improving the game through
152 technology. It's was the current practice that bothered them (Goodwin, 1986).

153 In 1992, six years after its introduction, an opposition group lead by George Young got
154 enough votes to eliminate it (King, McDonough and Zimmerman, 1994, in Dudko, 2013).
155 The owners voted 17 to 11 in favour of keeping replay; which fell short of the required
156 number of votes.

157 According to McCown (2016), at that time there were two main reasons behind the
158 decision to stop the instant replay: instant replays slowed down the game too much, and
159 it failed to get enough correct calls. Freeman confirmed there was a major problem with
160 incorrect reversals (Freeman, 1992).

161 Director of Officials Jerry Seeman indicated there were nine erroneous reversals, because
162 there was not the irrefutable evidence necessary to overturn a call made on the field.
163 Seeman also said there were 12 plays that should have been reversed, but weren't. Clearly
164 there was a problem with the system.

165 Some opponents of replay claimed it caused on-field referees to be timid because they
166 wanted *to avoid the embarrassment of having their decisions overturned before a*
167 *national television audience* (Freeman, 1992). But not all agreed. New Orleans Saints
168 General Manager Jim Finks, said “I think it's a step backwards for the National Football
169 League. I think it was something we had that was very unique, very effective... I think
170 we're going to regret the day we voted it down and I think we'll have it back in, very
171 frankly” (Freeman, 1992).

172 Seven years later, Finks words rang true. In 1999, NFL decided to try replay again. New
173 advances in technology led them to believe that the new digital system would have a
174 positive impact in the replay operation because it used no-linear re-winding, said
175 Commissioner Paul Tagliabue:

176 "Our goal is to take advantage of advanced technology to create the most efficient
177 replay system possible." "We believe we have developed that type of system. It
178 uses advanced technology, but it is simple to operate. We did not want to bring
179 back replay with the same system as 10 years ago. There will be a noticeable
180 positive difference in the overall replay operation"(NFL, 1999, para. 2).

181 To make a speedy review possible, high-definition signals from all cameras were sent by
182 fiber optic cables to the replay booth. The signals were recorded on two computer servers
183 and cued up by a technician. A video operator transfers relevant plays to a replay monitor,
184 which the replay assistant examines to determine if a review is warranted. A second
185 person in the booth watches the game action, announcing to the replay assistant whether
186 play has resumed; i.e. if it's too late to commence a review. Three monitors at field level
187 in open-air stadiums, one of them in a runway if there is inclement weather. Just two
188 monitors in domed stadiums.

189 In 2013, an agreement between NFL and Microsoft provided every team with Microsoft
190 Pro tablets. And in August, 2017, football referees replaced the traditional monitors to
191 the portable Surface Tablets (Darrow, 2017). "Instead of a fixed sideline monitor, we will
192 bring a tablet to the Referee who can review the play in consultation with our officiating
193 headquarters in New York, which has the final decision" (Sake, 2017).

194 In 2017, there were a total of 39,677 plays, but only 429 of those plays were reviewed.
195 With an averaged of 155 plays per game in 2017, just 1.1% of them are adjudicated using
196 instant replay (NFL, 2018h).

197

198 **The evolution of the Instant Replay rules and principles**

199 Since it began the NFL's instant replay review process focused on expediting instant
200 replay reviews and "ensuring consistency."

201 While it was necessary to use the same television feed that fans see at home, officials
202 also needed access to all camera views in order to isolate the best angle for consulting
203 with replay officials and to allow referees to make the best replay decisions.

204 Since 1985, "indisputable visual evidence" was the standard and only those calls were
205 reversed. Only "indisputable visual evidence" calls were revised by a replay official who
206 was monitoring the game feed from an in-stadium booth. When replay started, NFL
207 coaches had no way of challenging an official's on-field call, and the decision to review
208 any questionable call occurring inside the last two-minutes came from the replay official's
209 booth. The best a coach could hope for was that a seriously blown call might be spotted
210 and overturned by the officials themselves (Long, 2011).

211 In 1986 season, reviewable plays included (NFL, 2018b):

- 212 • Plays of possession or touching (fumbles, interceptions, receptions, muffs, or
213 ineligible player touching a forward pass);
- 214 • Most plays governed by the sidelines, goal lines, end lines and line of scrimmage
215 (whether a player is out of bounds, forward or backward passes or breaking the
216 plane of the goal line);
- 217 • And easily detectable infractions on replay (too many men on the field).

218 In 1989, the NFL decided to include every turnover and every touchdown. The protocol
219 established also that the coach could request two reviews, except after the two-minute
220 warning of either half, when the responsibility of calling reviews shifted from coaches to

221 the replay assistant in the booth. If both the coaches' challenges were successful, a third
222 challenge was allowed. This method is still utilized thirty years later.

223 In 1991, After a six-season run, instant replay met its demise in 1991 when 17 owners
224 voted against renewing the system.

225 In 1996, the new system approved for testing in 10 preseason games covered three
226 categories of plays: out of bounds, number of players on the field, and scoring plays.

227 Also, it continued permitting coaches to challenge on field rulings. Each coach could
228 challenge three plays per half — at the cost of a timeout per review. The league went
229 away from using replay officials in skyboxes and gave the game official authority to
230 review plays using a small booth equipped with monitors located on the sidelines. And,
231 importantly, referees now had only 90 seconds to make a decision.

232 Despite the changes, owners voted against implementation for the 1997 regular season.
233 The main concern was that each review costed teams a timeout, even when a challenge
234 was successful.

235 In 1999, after seven years without Instant Replay, a new system with digital technology
236 was implemented.

237 The new system with digital technology included four people in the box: a "replay
238 assistant," a "technician," a "video operator," and a "communicator."

239 The rules were adapted to address some of the main criticisms of previous iterations.

- 240 • To minimize delays, the league cut the number of challenges from three to two
241 per half.
- 242 • Coaches, unwilling to trade a timeout for any review, would now be charged a
243 timeout only for unsuccessful challenges.
- 244 • To allow coaches to focus at the end of each half on calling plays not which calls
245 to challenge — a replay assistant initiated all reviews inside the final two minutes
246 of each half.

247 The system was initiated by challenges from the head coaches in all but the final two
248 minutes of each half. During the final two minutes and in overtime, replay is triggered by
249 the replay official in the booth with no limits to how many replays he can request. Jerry
250 Seeman, then the NFL Senior Director of Officiating said: "Every play will be examined
251 in case there is a coach's challenge. The booth will operate under a 'two-minute' mode
252 the entire game, lining up replays of every play in case a challenge is issued (NFL, 1999).

253 TABLE 1 SHOULD BE AROUND HERE

254 In 2004, the NFL introduced a more low-tech solution: Coaches were given a red flag,
255 similar to the yellow official's flag, to throw onto the field in order to make their challenge
256 known. The instant replay rule was slightly changed to allow a third challenge to teams
257 if both of the original two challenges were successful.

258 In 2016, the NFL voted to expand its current replay system to include more reviewable
259 plays. The reviewable plays under the amendments included penalty enforcement, proper
260 down, spot of the foul, and status of the game clock.

261 The league also announced that the replay official and the members of the officiating
262 department at the league office could consult with the on-field officials during games to
263 provide information on penalty yardage, proper down, and status of the game clock.

264 In the 2017 season, the league continued to consult with the game's referee and replay
265 official from the Art McNally GameDay Central (AMGC), which was created in 2014.
266 However, all final decisions on all replay reviews come from NFL Senior Vice President
267 of Officiating, Alberto Riveron, or a designated senior member of the officiating
268 department with input from the referee (NFL, 2018a).

269 **The Coach**

270 Head coaches have not always had the right to review the play. They can communicate
271 with assistant coaches via a wireless headset communication device. A small number of
272 assistant coaches are in the press box from which allows them to have an expansive view
273 of the field. From this vantage point they can see everything happening at once. When
274 alerted by one of the coaches in the press box, head coaches can now activate a buzzer
275 system located in a belt pack to communicate with referees when they want a review.

276 The head coach also challenges a play by tossing a red flag on the field. At present, he
277 has two per game and as indicated previously, he can use them in all but the final two
278 minutes of each half and in the overtime period. The challenge requires the use of a team
279 time-out. If the ruling on the field isn't overturned, i.e., the official's call stands, the team
280 loses one of its six official time-outs.

281 If a team wins the challenge, it retains its time-out and the official's call is overruled. The
282 head coach is allowed one more if the coach wins the first two challenges, according to
283 NFL rules (NFL, 2018g):

284 A challenge will only be restored if a team is successful on both of its challenges, in which
285 case it shall be awarded a third challenge, but a fourth challenge will not be permitted
286 under any circumstances.

287 **The debate about eliminating instant replay**

288 Since 1985, Instant Replay has been used to overturn on-field decisions in situations with
289 indisputable visual evidence (NFL, 2018b). The replay scope is a controversial issue, with
290 some now arguing that replay should be used even in judgment calls or to reduce the
291 number of missed calls. A missed pass interference call near the conclusion of the 2019
292 National Football Conference (NFC) championship game between the New Orleans
293 Saints and Los Angeles Rams only heightened the cry for expanded use of replay. In fact,
294 in March 2019, NFL owners voted 31-1 to expand the use of replay to include pass
295 interference calls (Reuters, 2019).

296 The debate has been "a hot-button issue since games were first regularly televised in the
297 late 1940s" (NFL, 2018b). With technological improvements and the ability to analyze
298 plays frame by frame, video reviews were supposed to make ruling on plays more
299 objective and less controversial.

300 The controversy reached a fever pitch after the 2014 Divisional Round playoff game
301 between the Dallas Cowboys and Green Bay Packers. In the fourth quarter, with less than
302 five minutes to go in the game, Cowboys wide receiver Dez Bryant made a sensational
303 catch. After a challenge, the referees determined that "although the receiver is possessing
304 the football, he must maintain possession of that football throughout the entire process of
305 the catch," (Wilson, 2015), and overturned the call. The rules state that if there is even a
306 hint of doubt, i.e., it's not irrefutable, the call on the field stands.

307 Two Super Bowl-winning coaches Jon Gruden and Pete Carroll manifested their
308 disappointment to the Instant Replay system. In opinion of Coach Gruden, the NFL
309 should "Eliminate instant replay and let the officials call the game" and "let the naked

310 eye make the call.” Carroll considers “The scrutiny of the officials has become so intense,
311 they don’t call the game like they used to. I don’t like instant replay” (Boren, 2018).

312 Those critics notwithstanding, instant replay is so pervasive that the entire definition of a
313 catch, a defining element of the modern game, was up for debate (Denton, 2018). It
314 became so controversial that, in March 2018 the NFL changed the catch rule (Patra,
315 2018):

- 316 1. Control of the ball.
- 317 2. Two feet down or another body part.
- 318 3. A football move such as:
 - 319 ● A third step;
 - 320 ● Reaching/extending for the line-to-gain;
 - 321 ● Or the ability to perform such an act.

322 Getting calls right is important, but so is keeping games exciting and watchable. This
323 balances between keeping the rules simple and the fans, players, and coaches happy
324 seems complicated. Trevor Denton, sport editor of the Daily Trojan, explained that the
325 controversy is due to the frustrating ability to make games overly complicated and
326 convoluted (Denton, 2018). Even when the NFL tries to simplify a rule, and “remove all
327 the grey areas” as it did with the catch rule, fans, media, and teams can be left with more
328 confusion. (Patra, 2018). Fred Gaudelli, executive producer of NBC's Sunday Night
329 Football said, "This is my 29th year experience doing NFL games. The rules seem to get
330 more complicated and more nuanced every single year” (Seifert, 11/07/2018).

331 **Time Control in the Instant Replay**

332 Since the days of Art McNally using his stopwatch to calculate how much time was
333 needed to review a play, time control has been a very important issue when reviewing
334 play situations.

335 The game itself lasts an hour, split into four 15-minute quarters, but an average NFL game
336 takes on average of more than three hours to play (3:02 in 2008) and in the past decade,
337 that time has up nearly six minutes (Seifert, 18/09/2018). But what fills all that screen
338 time is different. The average number of incomplete passes, penalties called, and plays
339 reviewed are all the same or higher, meaning we’re spending a larger percentage of those
340 three-plus hours watching referees make decisions, players stand around, or commercials.

341 In 1986, the first regular season of the instant replay, officials reviewed 1.6 plays per
342 game, 374 in total, and only 10 percent (38) ended with a reversal of the ruling on the
343 field (NFL, 1999). During that time, reviews could be a maximum of two minutes. The
344 time permitted for reviews was later reduced to 90 seconds and after the 2005 season, the
345 NFL lowered the time limit for replay reviews from 90 seconds to 60. But the coaches’
346 challenges have the inherent capacity of slowing games down. A big downside to instant
347 replay is the effect on game times and the pace of play. “This can serve to cool down a
348 hot team on the verge of victory, or allow an exhausted defender a crucial extra minute
349 or two of rest” (Berman, 2017).

350 **Professionalism in NFL**

351 There are some people who think bad calls or missed calls is a result of a non full-time
352 officials. Despite significant rules and video reviews that officiating crews are required
353 to chart each week of the season, all NFL officials meet only once a year, for what's called
354 "The Clinic." There they learn the new rules, review plays, and get their new uniforms.

355 They have video footage material each season that is used by officials to analyze the plays
356 and improve their work.

357 The fact that NFL game officials are not full-time employees of the league, like those in
358 the National Basketball Association and Major League Baseball, has been recognized as
359 a problem by the media and by NFL executives. Although most of our officials are former
360 athletes or former players, “lot of them just started working game just to make a little
361 extra money on the side in high school and college,” explained NFL Vice President of
362 Officiating Dean Blandino (CBS, 2014). Prior to 2017, all officials were part-time and
363 worked in a variety of jobs outside football; teachers to bankers and insurance
364 underwriters to builders (O’Rourke, 2018). The NFL took action and in September, 2017
365 it hired 21 full-time game officials from among the current 124-person roster of officials
366 “to promote the common goal of improving every aspect of NFL officiating” (NFL,
367 2017).

368 **Technology is not infallible**

369 The instant replay system emerged from (and was a result of) improved broadcast
370 technology (NFL, 2018d).

371 In the first experiments, in 1985, the replay official was upstairs using two nine-inch
372 television monitors and two videocassette recorders capable of recording and
373 immediately replaying individual plays. The system worked with National Television
374 System Committee (NTSC) space resolutions of 720 pixels compared to the 1920 pixels
375 in the current full HD or the 3840 pixels in broadcasting tests for the new televisions in
376 UHDTV.

377 High definition and high speed cameras have certainly altered how fans engage with and
378 watch NFL games, which has led to more demands to get the call right. The resolution of
379 the current cameras have registering speeds of more than 1,000 fps and allow operators
380 to zoom in and analyze frame by frame with more details and determinate the accuracy
381 of officials’ decisions. Some contend technology has changed the game for the betterment
382 of the league, coaches and players, and even the fans.

383 The ever expanding and complicated communication systems used by the NFL requires
384 important coordination by the Federal Communications Commission (FCC). In 1975 only
385 referees were equipped with wireless microphones. Currently, wireless communication
386 is used extensively by coaches, players, and officials use during games.

387 The league debuted in 2014 a more efficient wireless official-to-official communications
388 system (O2O). The system speeds up the game by letting the officiating crew talk to each
389 other from a distance instead of face-to-face for every penalty. Previously, the field judge
390 would be required to run across the field to the referee to tell him the specifics of the
391 penalty, but O2O, has created greater efficiencies. For example, “*O2O saves time when*
392 *a field judge flags a clear pass interference 45 yards downfield and can tell the referee*
393 *about the call as soon as the play ends*” (NFL, 2018a).

394 Despite those improvements, the systems are still not perfect. Frequency coordinators
395 make sure anyone using a wireless microphone, walkie-talkie or radio is on the correct
396 channel to allow as many people as possible to access the bandwidth they need. “That
397 massive collision is happening in our stadiums every weekend,” said Michelle McKenna-
398 Doyle, the league’s chief information officer. “That has to get solved — whether we buy,
399 rent or partner with someone who owns frequency” (NFL, 2018d). Sometimes, weather
400 conditions or stadiums obstructions make hard for technology to function flawlessly.

401 Technology can not always provide an effective solution. According to Brian McCarthy,
402 NFL Vice President, “We are always looking for ways to responsibly incorporate the
403 latest technology into all facets of the game. For a number of years we have considered
404 various potential first-down measurement technologies but have not found one to date
405 that we were comfortable with to deploy” (Victor, 2017).

406 The NFL has challenges other sports don’t face. A Hawk-Eye spokesman told ESPN in
407 2015 that the cluster of players around first-down and goal-line plays could make its
408 system useless because 25 percent of the ball must be clearly visible for it to work (Victor,
409 2017).

410 Other challenges inherent to video technology is that an advantage can convert into and
411 disadvantage, as it occurs with slow motion. According to Coach Jon Gruden:

412 “I think slow-mo replay is the biggest problem with replay. When you’re looking at ‘is
413 it a catch or isn’t it a catch’ at that speed it’s hard to tell. It really is hard to tell. So I think
414 if you threw that slow-mo out, I think you’d get back to common sense. Let the naked
415 eye determine some of these calls. But it always looks like pass interference when you’re
416 going that slow; it always seems to look a little bit more dramatic in slow motion.
417 Sometimes it’s not realistic, I don’t think” (Boren, 2018).

418 **The importance to enhance fan’s viewing experience**

419 One of the reasons why video replay was implemented was because fans watching games
420 on TV had access to some details of the play game officials did not. Spectators had the
421 benefit of seeing a play dozens of times from multiple angle and hearing opinions of the
422 commentators whose job it is to keep fans interested.

423 However, with the increased use of replay the fan experience is different for those
424 watching the game on TV at home versus those watching in person. In the stadium, fans
425 are left waiting to know whether the catch in the end zone was a touchdown or an
426 incomplete pass. This time element breaks the act of celebration, as they often have to
427 wait for someone else to confirm what they saw with their own eyes.

428 In an effort to address the fan experience concerns on March 22, 2017, NFL
429 Commissioner Roger Goodell wrote an open letter to fans and said the league was going
430 to try and reduce the amount of time is spent on replays. This should improve consistency
431 and accuracy of decisions and help speed up the process.” The goal behind the change is
432 to “achieve a competitive game with fewer interruptions and distractions from action”
433 (Schwindt, 2017).

434 To coordinate actions with the officials, the TV broadcaster has a person on the sidelines
435 with a pair of red flags used to communicate to the referee whether to go long or short on
436 the timeout. They also use them to indicate when the network is back from commercial
437 and play is allowed to resume, and when the network is choosing to go to commercial for
438 a stoppage in play such as an injury or instant replay challenge.

439 The role of instant replay has had other impacts on its narrative event. Commercial breaks
440 are only allowed to begin during natural stoppages in play. Generally, after scores or
441 possession changes, but also when teams call timeouts. The teams have greatly improved
442 the narrative, not only for viewers at home, but also to fans in stadiums. The introduction
443 of giant video boards in the stadium offer fans a close details of players and plays. As
444 such, fans watching the game in the stadium enjoy an experience that more closely
445 replicates that of the fan watching the game on his or her couch.

446 **Conclusions**

447 The NFL has been one of the pioneering leagues in the use of video technology to help
448 referees. The use of Instant Replay has proven to be an important tool for officials and,
449 despite having been stopped for almost seven years, the new system approved in 1999
450 has remained and even improved with a enhanced digital technology which is faster than
451 the analogue process. Coupled with greater technological support, such as the creation of
452 the AMGC in 2014, where all the activity of review of plays and communication with the
453 referee team has been centralized, the NFL has a strong, but not perfect replay system.

454 As we have seen, not all stakeholders are in favour of NFL officials using instant replay
455 in. In spite of the criticisms, the NFL replay system has far more supporters of
456 maintaining instant replay in all surveys consulted. Further proof of its acceptance is that
457 in recent years, the protocol has included new play situations that were not initially
458 considered (e.g. reviews for pass interference). The NFL has been aware of the dilemma
459 of maintaining the essence of the game without giving up the advantages of technology
460 and has promoted measurements to achieve the high professional standards while
461 reducing the impact of the technology in the flow of the game.

462 Another aspect to highlight using video replay to help referees is the symbiosis between
463 officiating in the NFL and television broadcasting. The officiating profession has
464 benefited by using TV's technology and the visual language developed by sport
465 broadcasting producers. In return, officials have offered viewers and fans more
466 transparency in the refereeing process. TV has been able to integrate the Instant Replay
467 as part of the football narrative or story line by making the review process or the timeout
468 time part of the show. They've found additional revenue streams by using waiting times
469 to introduce more commercials. Nowhere is this more evident than the coordination
470 between the TV broadcaster and the referee to manage timeouts.

471 Instant Replay has been criticized by media and fans for several reasons. One of them is
472 that the rules are still not understood. Most fans genuinely do not know what is –and isn't-
473 a catch. The NFL has developed resources such as the NFL Rulebook with video
474 examples for the different sections of the rules and has promoted measurements to make
475 the rules easier to understand.

476 The other widespread criticism has been the lack of professionalism of the referees (i.e.
477 that a vast majority of them are not full-time employees). The NFL has promoted
478 measurements to achieve the professionalize of their officials by hiring full time referees
479 and preparing annual clinic to train with the technology and review the latest changes in
480 the rulebook.

481

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