Exploring and Eliminating Modern Illegal Sign-Stealing Sociotechnical Systems in Major League Baseball Using Assemblage Theory

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Gabriel J. Simmons

Spring 2021

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Advisor

S. Travis Elliott, Department of Engineering and Society

I. Introduction

Baseball players, just like other athletes, are always looking for a step-up on their opponent. One such advantage for a batter is knowing what pitch will be thrown by the pitcher, which has a significant effect on batting success (Guerrero, 1997). For that reason, stealing opposing teams' pitching signs to determine what type of pitch will be thrown has been a part of baseball almost since its inception, whether legally or illegally. However, recent advancements in technology have given rise to a surge in cases of the illegal variety of sign-stealing, such as with the 2017 Boston Red Sox and 2017 Houston Astros. It is imperative for MLB to address modern, illegal sign-stealing systems (SSSs) to both maintain the integrity of the game, and to preserve the public's trust – a critical element for any business – in order to prevent a further decline in fan viewership (Bejou et al., 1998). This STS research paper will seek to identify critical components and relationships in SSSs using Manuel DeLanda's (2006) version of Assemblage Theory (AT) in order to ultimately develop a novel, cost-effective anti-sign stealing assemblage (ASSA) that would work to effectively eliminate illegal SSSs from MLB.

Background: Sign Stealing in Baseball

Sign-stealing has about as long of a history as the game itself, with the first recorded SSS occurring in 1876 (Barna, 2019). Since that time, players have developed unwritten rules – an unofficial code "developed" and "enforced" by players themselves that determines what actions are "acceptable" or not – surrounding the practice of stealing signs, which have evolved over time. Turbow and Duca (2010) and Barna (2019) describe these unwritten rules in their current form. Essentially, any technologically unaided sign-stealing that occurs on the field or from the dugout by a player or coach immediately associated with the team is acceptable. Moreover, not only is this practice tolerable, it is *encouraged*; anyone possessing such a skill is highly valued by his team, and is often harnessed to give his team the greatest possible advantage. Throughout baseball, many of the best players have had a penchant for sign-stealing. Bob Turley, a pitcher for the New York Yankees in the 1950s, was so good at picking signs that he estimates that he called pitches out to hall of famer Mickey Mantle on over half of his 536 career home runs (Turbow & Duca, 2010).

On the other hand, any sign-stealing that occurs from beyond the field or the dugouts, or that uses some sort of electronic technology is unacceptable. There are many notable examples of this throughout MLB history, even before the recent Houston Astros SSS (HASSS) and Boston Red Sox SSS (RSSSS). The first recorded example occurred in 1876 when the Hartford Dark Blues put a bench player in small shack behind the outfield fence with binoculars, who would then relay the pitch the dugout using telegraph technology (Leitch, 2020). Dozens of similar examples have transpired in the 145 years since. Most involve stationing an organization member somewhere in the outfield scoreboard or bleachers and having them relay the signs through use of a designated scoreboard light, or through telephone (Verducci, 2020). One particularly innovative, dangerous, and rather humorous example is of the 1899-1900 Philadelphia Phillies. During a 1900 game, the Cincinnati Reds noticed that Phillies third base coach Pearce Chiles always tended to stand in the same spot during in the coaches' box, and seemed to have a weird leg twitch before every pitch. Sure enough, the Reds discovered after a bit of digging that the Phillies hid a box of telegraphic equipment below ground which would send an electrical buzz into Chiles' leg to indicate what the following pitch would be. This goes to show how great a length teams are willing to go to steal signs (Verducci, 2020).

It is important to note that for most of baseball history, these were in fact "unwritten rules." There was nothing ever written in MLB rule books around the so-called "wrong way" of stealing signs. However, that changed when then MLB Commissioner Bud Selig issued a memo essentially banning the “wrong way” of stealing signs in 2001, and this was later reiterated by now-Commissioner Rob Manfred in 2018, before the HASSS was discovered (Verducci, 2020). So, it is now officially illegal to steal signs using outside informants (individuals outside the field of play or in the dugout) or any sort of electronic technologies.

The Problem: Modern SSSs

Recent SSSs that have come to light have given ample media attention to the presence illicit sign-stealing in MLB. Most notable of these were the 2017-2018 HASSS and the 2017 RSSSS (Barna, 2019; Rosenthal & Drellich, 2020). Note that these are not the only two modern cases, as other allegations have been made against other teams, but these two are the most relevant (Verducci, 2020). The HASSS involved an organization member in the team clubhouse watching the catcher’s signals on a monitor, and giving some sort of audio cue to hitters, the most notorious version being the banging on a trash can cue (Rosenthal & Drellich, 2020). The RSSSS had a slightly more complicated system. Staffers in the video replay room would decode catcher’s signals, text the next pitch to the athletic trainer, who was in the dugout and was permitted to have an Apple Watch, who would then relay the sign to the runner on second base, who then then finally relay the pitch to the batter (Barna, 2019). It was later discovered that the Red Sox had other illegal SSSs they executed around that same timeframe, but for the purposes of this paper, only the stated SSS above will be studied (Rosenthal & Drellich, 2020).

While sign-stealing has been a part of the game for practically its entire existence, there have always been reasonable countermeasures teams could implement to reduce the effectiveness of SSSs. The main method of doing so was to change the pitcher-catcher sign encryption (PCSE), how pitchers and catchers communicate what pitch will be thrown.

Normally, when not worried about SSSs, there is a universal PCSE – the catcher putting down one finger is a fastball, two is a curveball, etc. However, there are many different ways this information can be delivered if the pair is worried about the opposing team's stealing their signs. For instance, instead of a catcher only putting down one signal, he might put down several, with a pre-determined number being the index that selects the pitch. A more complicated PCSE might be to determine the catcher's pitch index by adding the batter's uniform number modulo two plus the number of balls in the count plus one (*A Mathematical Analysis*, 2018). In the past, teams could change their PSCE midway through a game, or even an individual inning to minimize the effectiveness of SSSs (Turbow & Duca, 2010).

However, modern technology has disrupted this delicately balanced equilibrium. Machine Learning algorithms now possess the capability to quickly discover PSCEs (*A Mathematical Analysis*, 2018; Rober, 2019). In particular, Rober (2019) developed a cell phone app which he claims can effectively decipher most opposing coaches' touch signals, which instruct players when execute various baseball strategies such as to steal, hit and run, etc., after only a few data inputs. While this is not the exact same as decoding PCSEs, the two are remarkably similar, and it demonstrates the power machine learning brings. Here lies the problem: the pitchers and catchers no longer have a way to fight against this, unless they change their PSCE every couple of pitches. However, this is not feasible, especially given MLB's recent emphasis on pace of play (*Major League Baseball*, 2019). Some, including the MLB themselves, have sought technological counters to the problem, such as pitchers and catchers wearing communitive watches, random number generators, and even hidden lights viewable only by the pitcher (Feldman, 2020); however, players have expressed displeasure in complicating an already stressful environment by adding additional gear and technology to worry about

(Feldman, 2020). Therefore, it is clear that an alternative method must be developed to counter modern, illegal SSSs.

STS Framework: Using Assemblage Theory to Analyze SSSs

To study SSSs, Assemblage Theory (AT) will be utilized. Assemblage theory was inspired by the work of Deleuze and Guattari (1987), and was later developed into a full-fledged theory by Manuel DeLanda (2006). DeLanda's version of Assemblage Theory will be what is used to conduct the analysis of SSSs. This framework will be used due to its successful implementation in related literature exploring cheating in gambling (Johnson, 2018) and in online gaming (De Paoli & Kerr, 2009).

AT is similar to Actor-Network Theory (ANT) in many aspects, including its principle that relationships between actors, living or not, are essential to the functioning network (DeLanda, 2006; Latour, 1996). Both theories also assert that the whole is more than the sum of its parts. However, there are two significant differences between the two theories. First, ANT does not assume actors to be fixed while AT builds in as an assumption that humans specifically are unpredictable. As a result, ANT fails to adjust for the unexpected (Müller & Schurr, 2016). As has been established, modern SSS assemblages typically rely upon modern technology to work. The ever-changing and evolving nature of this human-developed technology is a breeding ground for new and unexpected results, which may be put to use in more sophisticated SSSs that anti-cheating ANTs will not be prepared to accommodate. Second, AT holds that it is the symbiotic relationship between the components that, when added to the raw parts, makes the whole (DeLanda, 2006). On the other hand, ANT claims that the whole is more than the sum of the parts because the parts by themselves are worthless. In other words, AT assigns value to the raw parts, and ANT does not, which has important implications (DeLanda, 2006; Müller & Schurr, 2016).

Johnson's (2018) method of developing an anti-cheating system is an example of the ANT approach. Johnson used a hybrid of ANT and AT to analyze gambling cheating systems, but employed ANT to approach a solution. Johnson (2018) argues that if one can find and exploit a single "weak link" in a cheating network and destabilize it, the whole system would crash (p. 317). This is a common viewpoint held by scholars of ANT – networks are fragile, and its properties exist only because of the components working together, and without any one component, that network will collapse (Latour, 1996). DeLanda (2006) calls these sort of interactions "relationships of interiority" (DeLanda, 2006). He disagrees with this perspective and instead claims that the opposite – "relationships of exteriority" – are how parts actually interact. In relationships of exteriority, components interact with one another to produce emergent properties, but that the parts themselves are autonomous, meaning they have value beyond their contribution to a given assemblage. In other words, DeLanda (2006) believes that a given component can be removed, replaced, and swapped out from an assemblage without necessarily causing the system to collapse. This seems to be a more practical approach to analyzing SSSs and in developing an anti-sign stealing system because there are so many ways to teams can illegally steal signs, many of them only requiring a single swap in equipment to achieve the same result. For instance, one SSS might have an outside informant in center field signal to the batter using a laser pointer, and another SSS might have them signal to the batter using different colored towels. Thus, it would be silly to say that SSSs "collapse" simply by banning laser pointers at MLB games, because laser pointers can simply be replaced by colored towels.

Developing an Anti-Sign Stealing Assemblage to Reduce SSSs

As previously stated, the main purpose of this paper, beyond simply analyzing modern SSSs through AT, is to develop an anti-sign stealing assemblage (ASSA) that can best reduce illegal SSSs in the future in terms of technological effectiveness and cost. It has been established that using AT forces us reject a solution that simply targets *any* component of the assemblage because the system will not *necessarily* collapse due to the autonomy of components in an assemblage (DeLanda, 2006). This makes it appear like any solution targeting a given component of an assemblage will be ineffective; however, that is only partly true. In the following paragraph, a novel, practical implementation of AT will be argued. A practical interpretation of AT is necessary since we seek to apply it, a theoretical model, practically to a real-world situation.

This paper contends that there are two types of components in an assemblage – essential components (ECs) and non-essential components (NECs). ECs are those that are required to remain in the assemblage for it to retain critical emergent properties. Removing these would cause the assemblage to undergo a complete change to its fundamental identity. On the other hand, NECs are those that can be easily removed and swapped with something else that leave its core identity intact. To give an example, consider a pack of post-it notes. Some post-it notes are designed to be completely sticky on the back, others are only sticky at the top of the note. The application of the sticky substance to the *whole* post-it note is irrelevant to a post-it note's identity. It is still a post-it note, just a different type. On the other hand, if the sticky substance were removed entirely, it would cease to be a post-it note – it would just be a pile of tiny, square pieces of paper.

Note that this distinction also relies heavily on the initial description, comprised of any number of descriptive adjectives and a single noun, of what you are addressing (Some examples include a computer, a pink t-shirt, a big, red dog, etc.). For instance, this paper seeks to reduce *illegal* SSSs in MLB. If a component of *illegal* SSSs were removed that caused *illegal* SSSs to reassemble into *legal* SSSs, then that would constitute an EC, since the distinction of *legal* and *illegal* is declared in the initial descriptor. No additional descriptions may be assigned to an already declared assemblage. If some components were removed from illegal SSSs that only eliminated *some* types of illegal SSSs – let's say only ones that require banging on trash cans to work – that would be considered a NEC. After all, removing trash cans from the dugout does not eliminate all forms of illegal SSSs, only some. If one had the ability to add descriptors to a declared assemblage, this would give rise to an infinitely low-level counterargument, which reduces to an ANT argument.

One could validly claim that if you go low-level enough in terms of what one calls "emergent properties" – in other words, if one added an infinite number of additional descriptions to some noun -- every single component can be argued to be essential, which reduces to an ANT argument. For example, say that two people were arguing about what are essential components for a piece of college-ruled notebook paper. One could make the case that the lines on the sheet *must* be blue. If they are green, or orange, or gray, or any other color, then that piece of paper is absolutely indistinguishable from a "real" sheet of college-ruled note paper. By that logic, one could claim *anything* to be essential. However, this argument adds parameters to the initially defined assemblage. It changes "college-ruled notebook paper" to "blue-lined college-ruled notebook paper." If the color of the lines were specified prior to the argument, then this would be a valid claim; however, it was not specified, and is therefore a NEC.

The purpose of making the distinction between ECs and NECs is not to make a "backdoor" ANT argument for a solution, but more so to generalize considered components. The more general one gets in identifying components in an assemblage, the more essential they become. For instance, can a pen be called a pen if it does not include ink? Theoretically, yes it can because one could replace the ink with some other liquid that would leave distinct markings on a page. This is too specific. A more general question would be: "Can a pen be called a pen if it does not have (or never had in the first place) any sort of liquid that can leave disguisable markings behind on a writing surface?" Of course, the answer would be no. This is where the strength of differentiating ECs and NECs arises – the removal of ECs results in at least a major disruption in an assemblage's normal functioning, and it retains the built-in robustness inherent in AT such that it still accounts for human unpredictability.

The examination of ECs versus NECs is not meant to discount the requirement of relationships from an assemblage. As AT suggests, relationships, when added to the parts, constitute the whole (Deleuze & Guattari 1987; DeLanda, 2006). Thus, expanding upon the necessity of ECs to an assemblage, any relationship *that is attached to an EC* is also required for the assemblage to function. Therefore, in the analysis to follow, ECs of illegal SSSs and their pertinent relationships will be studied and considered, with the goal finding the most reliable and cost-effective one to remove in order to develop an operative ASSA, harkening back to Johnson's (2018) method of finding the "weakest link," but from a strictly AT perspective.

II. Analyzing the SSS Assemblage: Its Parts and Relationships

In this section, significant ECs and EC relationships will be explored by examining its involvement in two recent examples of illegal SSSs – the RSSSS and the HASSS. Then, the element or relationship will be examined in terms of the feasibility of its elimination. The simplicity, cost-effectiveness, usefulness, and feasibility of its removal will be explored. Note that the list of ECs and relationships are not necessarily all-inclusive. Only those that were deemed pertinent for discussion are included.

Essential Components

Players. The most obvious essential component to an SSS are the players themselves, or more specifically the batters. If the players are removed from a SSS assemblage, obviously it would not exist – and neither would baseball itself. In the HASSS, batters would listen for some audio cue, such as a trash can banging, to determine the coming pitch (Rosenthal & Drellich, 2020). In the RSSSS, players served two roles. The first role was only pertinent when a Red Sox player reached 2nd base, where the batter could easily see them. The runner on 2nd would relay the message received from the athletic trainer to the batter through some discrete body signal. The second role was, of course, the batter himself who watched the runner on second for some sign from the runner (Barna, 2019). Obviously, removing players from SSSs would make no sense. However, players have relationships with most other components in SSSs, since they are the ones SSSs seek to aid. These relationships will be explored later.

Equipment. Equipment refers specifically to *illegal* sign-stealing equipment. This moniker applies to all electronic equipment, as defined by Selig's 2001 and Manfred's 2018 memos (Verducci, 2020). This definition also applies to binoculars and telescopes, which MLB has already banned (Bogage, 2019). In the case of the HASSS, this would refer to the video monitor at the edge of the border between the clubhouse and the dugout where staffers observed the signs, as well as the center field camera they used to pick up said signs (Rosenthal & Drellich, 2020). Both were theoretically allowed to be present, but the use of them for the purposes of sign-stealing was forbidden. On the other hand, the RSSSS employed an Apple

Watch and the replay monitors displaying the television feed in their system (Barna, 2019). Again, both technologies were allowed to be there, but were not intended to be used for SSSs. The removal of illegal electronic technologies is still not completely feasible, but it is much more so than players. Certain types of equipment can be outright banned relatively easily, such as Apple Watches in the dugout during games. Others, such as perhaps scoreboard lights which were used in some SSSs in the past, would be much more difficult to regulate (Verducci, 2020). However, all else considered, the removal of some technologies from the dugout and field of play would be beneficial in the effort to reduce SSSs, simple to implement, and relatively cost efficient to regulate.

Outside Informant(s). Outside informants (OIs) are those who are being used by the team in question to decode and begin the communication line to the relevant inside informants. In other words, OIs must be outside the field of play and dugout. OIs are ECs within illegal SSSs because, without them, that would mean that a team were only using inside informants – those on the field or in the dugout -- to steal signs, which is perfectly legal, and encouraged (Turbow & Duca, 2010). Inside informants by themselves cannot use illegal sign-stealing equipment because MLB has already banned all such equipment that could be used for those purposes in dugouts. While it is certainly possible for inside informants to sneak in illegal equipment, the appropriate ASSA is already in place for that situation, and as such, this paper will not focus on such scenarios and will assume these cases to be resolved as well as can be reasonably expected. Therefore, we may also then assume that any use of illegal equipment must happen beyond the field of play, from an OI. Indeed, both the HASSS and RSSSS had such people. The HASSS employed clubhouse personnel, who were not in the dugout, to signal loudly enough to the batter to be heard (Rosenthal & Drellich, 2020). The RSSSS had staffers in their video replay room transmitting the signs to the athletic trainer (Barna, 2019). OIs by themselves would also be unfeasible to be removed. OIs can be *anyone* not on the field, including on-roster players on the team who are not playing that day. A particularly famous example of using bench players as OIs in a SSS is of the allegations against the 1951 New York Giants, who were suspected of using pitchers in the bullpen, who were located deep in the outfield at their home ballpark, to signal the pitch to batters by tossing a ball a certain height in the air (Verducci, 2020). Therefore, since even players can be OIs, and because it has already been established that players cannot be feasibly removed, that means that it is equally impractical to remove potential OIs from SSSs.

Relationships Involving Essential Components

Players & Motivation – Prisoner's Dilemma and Other Motivating Factors to Cheat. Players have two common interests which drive the majority of their professional actions – money and winning, and there exists a positive relationship between the two. Players want to win to earn salary bonuses for postseason play. In 2008, Vrooman (2012) calculates that players received, on average, approximately $18,000 per postseason game. More recently, in 2017 Kirshner (2017) estimates that players received an average of nearly $25,000 per postseason game. This is not to discount the players' competitiveness, because make no mistake, most if not all players at the major league level are highly competitive. Kinyon (2020) suggests that this drive to win introduces psychological factors which can cause a lapse in a team's cost-benefit analysis of whether to employ SSSs. Such factors include representative heuristics, availability bias, and anchoring heuristics (Kinyon, 2020). One of the themes present in Kinyon's argument is that of the "Prisoner's Dilemma." That is, there are two options for two opponents, an optimal one, and a sub-optimal one. The catch is that if both select the optimal option, both receive punishments, as is the case if both teams employ SSSs. However, one does not want to be the team that selects the suboptimal option while the opponent chooses the optimal one, as that would punish only oneself (Kinyon, 2020). In other words, Kinyon is claiming that the fear of being the only one not gaining some advantage while one perceives everyone else as having said advantage influences teams to employ illegal SSSs to "keep up" with the competition. Kinyon (2020) was specifically studying the HASSS when making this assertion; however, it is interesting to note that immediately after the Red Sox were caught for their SSS in 2017, they immediately countered by claiming that their opponent during the games in question, the New York Yankees, were also stealing signs illegally (Schmidt, 2017). This accusation is noteworthy because it demonstrates the Red Sox are at least paranoid of other teams conducting similar illicit SSSs, which suggests that the actions of their opponents played a factor in their decision to employ an illegal SSS.

Communication Between Outside Informant(s) & Players. Every illegal SSS must have a communication network that begins with some outside informant, and ends with the batter, and it all must happen in just a few seconds. The RSSSS's communication network went started with the OI in the video replay booth, traveled to the athletic trainer through text message, was relayed to the runner on second base through some sort of signal, before finally being relayed to the batter, all in only a matter of seconds (Barna, 2019). The HASSS's network was much simpler. Their OI in the clubhouse banged on a trash can to communicate directly with the hitter (Rosenthal & Drellich, 2020). The RSSSS used electronic communication along the path, but the HASSS did not, which helps make a distinction between two types of communication networks – electronic and non-electronic.

Further, two types of OIs must be distinguished: visible and invisible. Visible OIs are those that are visible from the field of play by all – inside informants, players, the opposing team, the media, fans, the league, etc. Invisible OIs are those that that are not visible from the field of play, meaning no one can see them. Both types have the capability to communicate with inside informants or players directly, with no need for electronic communication devices, whether that be through verbal or visual means. For example, a visible OI could be posted in the center field bleachers and wave a different colored towel to signal different types of pitches to the batter. Since visual communication is possible for visible OIs, they are far more likely to use non-electronic communication techniques, but this is not always the case. For instance, the HASSS had a staffer in the clubhouse, an invisible OI, communicate auditorily with the players by banging on a trash can (Rosenthal & Drellich, 2020). They could do this due to their proximity to the field. The fact that non-electronic communication is possible for all OIs makes it harder to regulate, but it is easier to observe by human eyes and ears. Electronic communication is much easier to regulate, as will discussed later. In any case, limitations in communications networks offer a potential exploitable hole for the ASSA, but not for all illegal SSSs.

Outside Informant(s) & Equipment. Both visible and invisible OIs face the same issue. Neither can see the catcher's signs without electronic aid. Visible OIs will be either too far away from home plate to see the signs, or will be viewing the field from an angle that prevents them from seeing them. For instance, if a team employed a fan in the center field bleachers to pick and relay signs to the hitters, the fan would have to use binoculars, a telescope, a high-powered camera, or some other banned equipment to steal the signs. Invisible OIs, of course, cannot see the field in the first place, requiring them to watch the game using some other illegal electronic means. This can be seen in the RSSSS's case, where video staffers watched the game using monitors in the replay review room (Barna, 2019). Similarly, the HASSS stationed an invisible OI in the clubhouse at a television showing the game happening through the lens of a center field camera (Rosenthal & Drellich, 2020). In both cases, OIs require illegal equipment to observe the catcher's signs. This is a significant weakness of illegal SSSs, and is one that can be feasibly eliminated. The ASSA developed in the discussion section will heavily rely on this weakness.

III. Discussion: Developing an Anti-Sign Stealing Assemblage

To develop the ASSA, as discussed in the introduction, the weakest EC or relationship involved an EC will be targeted. The goal will be to reduce or eliminate, to the best of MLB's ability, that aspect in SSS assemblages. That said, given that there is more than one weakness that can be exploited, steps to take and policies introduced here will not be limited to only the targeted relationship. The determination of whether to include these supplementary actions depended on the cost of adding these extra features compared to the probability of future SSSs getting around the original targeted aspect of current, modern SSSs. In other words, the extra qualities of the ASSA are an insurance measure to make it even more challenging to get around.

The Proposed Solution

The solution presented below mainly targets the relationship between OIs and equipment. Specifically, the OI's inability to see the catcher's signs without some electronic device is pursued. Other parts of the solution target limitations in the OI's capacity to communicate quickly and easily with inside informants or players. In all, six actions are presented which together constitute an ASSA to prevent against modern SSSs. The first four parts target the communication networks between OIs and inside informants and players, the second-to-last attacks the intended target – OIs and their need to visually see the catcher's signs, while the last part seeks to decrease player motivation to cheat.

Clubhouse Monitors. MLB could employ somewhere between thirty to sixty clubhouse monitors who oversee everything happening in the clubhouse during games. This is necessary to prevent SSSs similar to the one the Astros pulled off. Basically, the clubhouse is the only place an invisible OI can be stationed such that they can non-electronically communicate with an inside informant or players, directly. By the MLB's standards, the cost of hiring this many people for such a simple job should be relatively cheap, especially for the demand that job would bring. The responsibility of a clubhouse monitor would be to keep an eye on any individual inside the clubhouse during games to ensure they are not passing signals to inside informants or players.

Banning All Electronic Equipment from Dugouts. The presence of technology in dugouts, whether that be smartphones, iPads with internet turned off, or Apple Watches present too much of a temptation to teams – smart technology like these are just too easy to exploit. No non-essential electronics should be in the hands of an inside informant. This prevents inside informants from electronically communicating with OIs, meaning that they can only communicate non-electronically, of which clubhouse monitors, anti-cheating monitors (see below), and audio-visual difference detection software (see below) eliminate. This would be of no cost to the league to implement, although they might initially get some push-back from the players about the policy.

Implement Software that Detects Visual and Audio Changes Between Pitches. There already exists a lot of software that compares the differences between images and between audio files. MLB can harness this technology cheaply and effectively to detect visual or auditory communication between OIs and inside informants or players. For the visual difference software, this could run as simply as having a camera trained onto the outfield bleachers – everything within the batter's eyesight – and giving a warning if it sees patterns in the colors of certain pixels based on the coming pitch, or of specific types of movement, or any other similar details like this that can be used as visual communication. For instance, the software might realize that a fan in center field always waves an orange towel when the pitcher throws a fastball, but waves a green towel when he throws a curveball. Additionally, MLB could place a recording device either in or close to the dugout which will listen for any auditory differences of based on the coming pitch types, in much the same way as the visual software would work (Guezouli et al., 2013). For example, it probably would not take very long for the software to detect a team banging on a trash can a specific number of times before each pitch. Nothing would happen right away when suspicious activity is flagged by the software, as false-positives may be plentiful, especially when the software is new. Flagged behavior would need review by an employee of the league.

Anti-Cheating Monitors. Anti-Cheating Monitors would be the ones reviewing the flagged behavior from the software. They would review the flagged media, and have the ability to observe it happening in real time and ultimately make a determination if anything suspicious is transpiring. Further, they would have a direct line to pertinent ballpark officials so that they could inform them of the activity. From there, the issue will be dealt with appropriately to, with as little force as necessary, cease the behavior, with the worst punishment given being ejection from the stadium. The human-machine anti-cheating monitoring system, if working properly, would quickly and efficiently identify non-electronic communication from OIs. In addition, since the machine would do most of the work, unless the software returns many false-positives, it may not even be necessary to employ additional personnel to monitor the software. It could be simply added onto someone else’s responsibilities. Thus, this would be a very simple and inexpensive solution for MLB to employ with very little downside, even if it does not quite work properly.

Television Delay. This part focuses on the main relationship of interest – OIs and equipment. Telescopes and binoculars are already banned by MLB (Bogage, 2019). However, cell phones are perfectly legal. All a visible OI would have to do is but watch the broadcast of the game on his phone and relay the signs to the batter. The same goes for any invisible OI. Even before the news of the HASSS broke, MLB recognized this and implemented a new rule that required all television monitors in the clubhouse and bullpen to be shown on an eight-second delay (Bogage, 2019). The only exception is the replay booth, which now has an MLB-employed monitor present to avoid a similar SSS to the RSSSS which used the replay booth to pick the signs. However, this is not enough. A player could simply walk into the clubhouse, pull out his phone and start streaming the game with little or no delay, and carry out the SSS as usual. A solution to this would be to simply show the game on a similar eight-second delay that all other video monitors already do. MLB would have to strike this deal with all broadcasting networks and potentially even more than that to get it done, so perhaps this part is a bit less feasible than others. However, if able to be carried out, pretty much only self-owned and operated equipment could be used to steal signs, which has mostly already banned by MLB, with a few exceptions (Bogage, 2019). This one solution would solve many problems.

Stricter and More Consistent Punishment. Kinyon (2020) indirectly identifies this as an issue in his cost-benefit analysis of why the Astros executed their SSS. He contends that they figured any punishment they would receive would be insubstantial compared to the benefits – and they just might have been right. Many argue the punishments handed out to the Astros were not severe enough, with players suffering very limited penalties in particular (Baer, 2020). Baer also notes that it would have been messy to try and punish each individual player, which is a fair point. However, it seems a bit odd that while the manager A.J. Hinch and team executives suffered the most, the ones who benefited the most from the illegal SSS – the players – received essentially no punishment whatsoever (Baer, 2020). If MLB wants to prevent similar SSSs in the future, they must have a *consistent* system in place that makes in clear that all players shown to be involved will be issued penalties such as suspensions, fines, etc. This will increase the cost of carrying out an illegal SSS and perhaps detract more teams from doing so.

Potential Problems with Solution

The six-part, independent solution is not designed to eliminate illegal SSSs from baseball forevermore, as under AT that would be impossible. Humans are too unpredictable, and will develop new relationships and components that can be plugged in to a new assemblage which accomplishes the same objectives as the ones which this paper seeks to prevent (DeLanda, 2006). Even within the solution itself, there are exploitable holes. To give some examples, MLB clubhouse monitors or human anti-cheating monitors can be bribed to "overlook" certain activities. Holes in the AI flagging software might exist. Perhaps one who knows its inner workings could sell information about it to a team, who then exploits its weaknesses, and develops a new illegal SSS in the process. There are an infinite number of other ways people can get around these limitations – humans are rather creative. Instead, the objective of the presented ASSA is to sharply decrease the probability of illegal SSSs occurring in the foreseeable future, which this author believes to be a very obtainable goal.

IV. Conclusion

The high prevalence of modern SSSs in MLB in the last five years has been alarming. Sign-stealing has been a part of the game for nearly a century and a half. However, modern SSSs are becoming increasingly technical. The potential now exists for artificial intelligence and similar types of software to rapidly decipher even the most complicated of PCSEs. It is crucial for MLB to nip the practice of illegally stealing signs now, preventing similar sociotechnical assemblages like the HASSS and the RSSSS, as well as any current or future assemblages employing advanced software as previously mentioned.

This paper framed the problem using DeLanda's (2006) AT such that each SSS is considered an assemblage. Further, it was novelly shown that removing any ECs or relationships involving ECs would severely debilitate the SSS assemblage. Though, it was noted that it would not completely destroy it, as the unpredictability of humans and the future allow for unforeseen events, which is built into the AT framework. Finally, a practical, independent six-part solution was described, mainly targeting the relationship between OIs and equipment needed to see the catcher's signs. Although, other "weak" relationships were targeted too as an insurance measure in case the said relationship somehow changed in the future to allow for illegal SSSs to rise again. It is hoped that the presented solution, if implemented, will reduce or eliminate the seemingly common illegal SSSs running rampant in the game today, giving players and fans more confidence in MLB results and the integrity of the game.

Words: 6452

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