Australian Government
Australian Institute of Family Studies
Australian Gambling Research Centre

How electronic gambling machines work
## EGM structural characteristics

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Summary

The purpose of this paper is to provide policy makers, regulators and others with information about key design characteristics of electronic gambling machines (EGMs). These characteristics include auditory and visual cues, "game maths", and price and prize structure. They also include elements in the games that render them attractive to EGM users, and which appear to be associated with the establishment of persistent game utilisation or addiction. It is hoped that a better understanding of these characteristics will help policy makers and regulators to frame policies and interventions that will reduce harm to gamblers from EGM use.

KEY MESSAGES

- Electronic gambling machines (EGMs) are computers utilising sophisticated techniques, designed to maximise spending and "time on device" per user.

- EGM designs very successfully employ psychological principals to maximise users' bet sizes and machine usage. These characteristics have the effect of increasing the addictive potential of EGMs.

- Users of EGMs, and policy makers as well, are mostly not well informed about the way the machines work, or the complex "game maths" behind them.

- Internationally, Australian EGMs are known for their ability to maximise users' spending and "time on device", yet Australia has been slow to develop adequate policy responses to reduce harms.
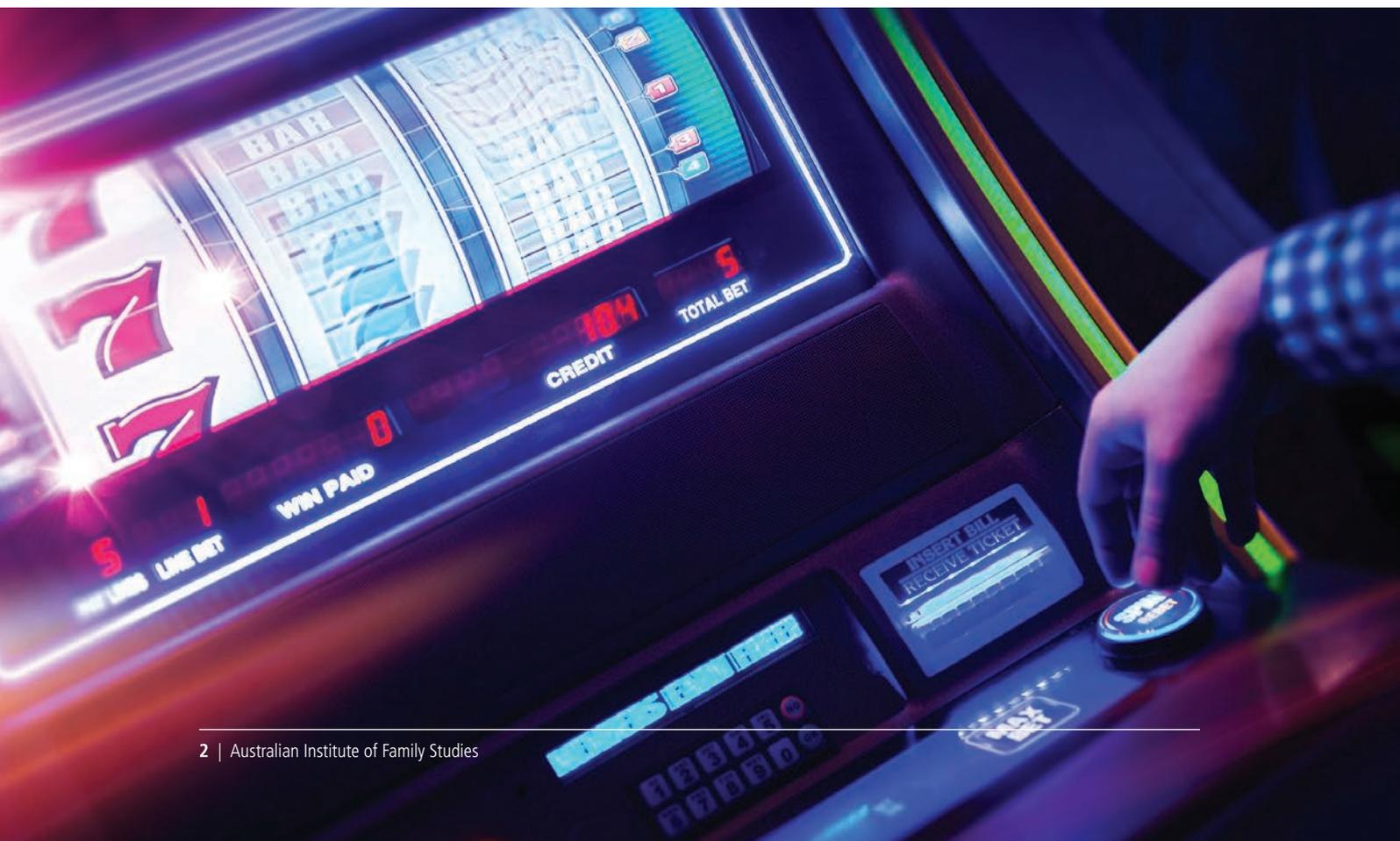
What are electronic gambling machines?

Electronic gambling machines (EGMs), known colloquially as "pokies", have their origins in older style lever-operated machines which spun a series of physical reels, on which were portrayed a number of winning symbols. These devices used mechanical stops to arrest the spin of the reels in order, usually from left to right. When the winning symbols lined up, a prize was delivered, usually via a coin dump into the tray at the bottom of the machine.

Today, EGMs are computers. However, many are still reminiscent of older style games, being housed in large upright boxes and utilising "reels" that appear to spin.

At the core of any EGM is a random number generator. When a button or touch screen is activated, the computer accesses the numbers generated at that point in time and converts them to a display on the screen. The numbers correspond to a position on a "reel map"—the number and order of symbols on each virtual reel—and a "pay table"—the prizes awarded for each combination of symbols appearing on a line. For example, if the random process generates three Kings, this will be mapped to the pay table to pay, e.g., five credits.

> The intersection of a machine's reel map and pay table is represented by its "game maths"—which manufacturers describe in a document called a probability accounting report, or PAR sheet.
>
> Harrigan & Dixon, 2009

Every country has its own regulations governing EGM design. This paper focusses on so-called "Australian-style" EGMs (Schüll, 2012). In the documentary film *KaChing! Pokie Nation* (Lawrence & Goldman, 2015), Schüll comments that Australian-style machines are seen internationally as sophisticated and successful at achieving their goal—attracting people to use them, and encouraging repeated expenditure. They were rapidly adopted by American casino operators after being introduced there in the 1990s.

In Australia, EGMs are required to conform to the *Australian and New Zealand Gaming Machine Technical Standards*. However, each jurisdiction requires slightly different parameter settings (return to player ratio, maximum bet, credit load-up limit etc.). Each jurisdiction also requires EGM games to be approved separately, although some regulators take notice of game approvals in other Australian jurisdictions. Australian jurisdictions outsource game approval testing to licensed private agencies, which certify games as compliant.

> Australian machines' PAR sheets (their game maths) are not directly scrutinised or retained by Australian regulators.

Policy and regulation

In Australia, EGMs account for over $14 billion in gambler losses, or 62% of all gambling revenue. Around $2.5 billion of those losses occur in casinos (Queensland Treasury, 2016; Productivity Commission, 2010).

A recent study using nationally representative data from four countries found that while high expenditure on EGMs is associated with the most harm, harm can also accrue to those spending more moderate amounts (Markham, Young, & Doran, 2015).

Policy makers and regulators tasked with protecting gamblers and reducing harm associated with EGMs have at their disposal *The Australia/New Zealand Gaming Machine National Standard* (Australian and New Zealand National Standard Working Party, 2015).

The standard currently applies to all Australasian jurisdictions and specifies a range of technical standards required for approval by regulators. It is not without its problems. One is that each Australian jurisdiction applies distinct parameters (Australian and New Zealand National Standard Working Party, 2015, pp. 76–80). Another is the orientation of the standard towards technical, rather than harm prevention or reduction, priorities (Livingstone & Woolley, 2007).

Arguably the biggest problem with the standard is that understanding of specific "structural characteristics" of EGMs and their relationship to gambling harm and behaviours is not well reflected in it.

EGM **structural characteristics** (see below for more detail) are discrete but integrated elements of game design that in the aggregate constitute the game portrayed on an EGM. They are the "building blocks" of an EGM game.

> A better understanding of the role and importance of EGM structural characteristics could help develop better policy and deliver more effective harm prevention or minimisation interventions.

Reducing harm from EGM use

Some EGM characteristics may add to the enjoyment of those who derive pleasure from the machines. The issue for policy-makers is to balance this consideration against the harm generated by an EGM characteristic. This is identical to challenges arising when developing policy and regulation for other consumer goods, services and public practices (e.g., motor vehicles).

EGM characteristics are not accidental aspects of game design, nor are they immutable. EGMs have evolved rapidly in recent years to utilise many characteristics known to increase the addictive potential of games, and, as a corollary, increase the likelihood of harmful consequences for a substantial proportion of those who use them.

The process of game evolution has been well documented (Schüll, 2012), and its rapid growth has delivered digital devices that far exceed the revenue performance, and addictive and harm-inducing potential, of older, mechanical poker machines.

Given the rapid and continuing evolution of EGM design, it appears that regulators are not always aware of the implications of some aspects of game design. Australian regulators have all "outsourced" game testing to commercial operators who determine whether games meet the standards, and issue certification.

> Understanding the mechanism by which a characteristic of EGM design boosts reinforcement (e.g., by disguising losses as wins—see below), and thus increases the machine's addictive potential, could help craft policy responses that would limit the harmful impact of such a characteristic.

Research relating to many specific game characteristics and configurations is relatively modest (Parke, Parke, & Blaszczynski, 2016). Facilitating researchers' understanding of the new generation of EGMs would assist regulators in the crafting and application of standards.

Rapid progress in understanding the impacts and effects of EGM design could be facilitated by providing bona fide researchers with regular access to probability accounting reports (PAR sheets), and actual game data. Improved access to actual game data would be supported by the introduction of comprehensive pre-commitment systems, enabling de-identified data sets to be generated.

A public health approach

Gambling regulation has become overtly aligned with public health principles in recent years. Gaming machine standards and other requirements for approval of EGM games provide an important set of tools to incorporate practical and highly effective mechanisms for the prevention and reduction of harm, and the improvement of consumer protection measures.

Understanding *the effects of* EGM structural characteristics, and re-orienting the national gaming machine standards towards harm prevention and reduction priorities, represents a reflection of a fundamental principle of the public health approach. Access to better information and real-world data would be of great benefit in achieving this goal.

However, there is already ample evidence available of the relationship between some important EGM structural characteristics, and the harms associated with the use of EGMs. Acting on this understanding would provide considerable benefits.

> As well as protecting gamblers, minimising harm would permit the development and continuation of a sustainable EGM gambling industry, where the benefits of EGM use are largely retained.

The price of EGMs

Like other forms of gambling, EGMs have a price, a kind of negative return on investment known as the "return to player" ratio.

Return to player ratio

A return to player (RTP) ratio is the proportion of each wager an EGM game is designed to return on average to users. RTP represents an average deduction from the user's wager for each bet, calculated over the game cycle.

Australian jurisdictions prescribe a range of minimum RTP. In clubs and hotels in NSW, Victoria, Tasmania, Queensland and the Northern Territory, minimum RTP is set at 85%. In the ACT, minimum RTP is 87%, and in South Australia it is 87.5%. EGMs in casinos generally have a higher minimum RTP (reflecting their greater turnover and higher bet limits).

If minimum RTP is set at 85%, this means that, *over the long term* (often described as the "game cycle"), the game must return to the user at least 85% of the amount they wager.

The prescribed method of calculation for this to be achieved varies between jurisdictions. In Victoria, the actual RTP is calculated by assessing the aggregated wagers and total returns paid to users over the course of a year for *all* EGMs operating within a specific venue (*Gambling Regulation Act 2003* (Vic), p. 335). In other jurisdictions, an individual machine must return at least the minimum RTP over its game cycle. The game cycle, however, may be many years, because of the large number of possible outcomes, as discussed below.

A machine's theoretical return to player ratio (TRTP) is determined by its "game maths": the interaction of the configuration of the game's "reel maps", the number and order of symbols on each virtual reel, and the "pay table", the prizes awarded for each combination of symbols appearing on a line.

A game's TRTP can be readily determined mathematically, but it is important to note that TRTP is very unlikely to be achieved on an EGM game in the scale of an individual user's interaction with the game. Most EGM games have a very large number of potential outcomes—frequently 50,000,000 or more.

Dolphin Treasure, a relatively old-style EGM game still provided in many Australian venues, has 35,640,000 possible outcomes. This can be derived from the number of symbols on each of the

five reels utilised by the game (30x30x30x30x44). Thus, the time to traverse the full repertoire of possible outcomes of such a game would require a *minimum* of 5.6 years of continuous use (at game intervals of 5 seconds per spin, for 24 hours per day, every day).

However, the probability that even such a time commitment would produce all possible results in an EGM game is very close to zero.

The reality of player returns

The price of EGM games can be defined as 1-RTP, so that an RTP of 85% (or 0.85) produces an average price per wager of 0.15 or 15%. That is, the "house edge" for Australian EGMs is as high as 15%. It is rare for such an outcome to be achieved in the short term.

> As prize outcomes over short periods are subject to significant variation, it is difficult for players, via their gambling experiences, to determine player returns with any accuracy.
>
> Woolley, Livingstone, Harrigan, & Rintoul, 2013

However, in an experiment where the price of a game was varied substantially (and rather more than occurs in practice—between 2% and 15%), users were reportedly able to detect this (Dixon, Fugelsang, MacLaren, & Harrigan, 2013).

In some Australian jurisdictions, RTP must be displayed on a user information screen, while others prescribe that such information must be available at a venue upon request. But even when disclosed, the question remains whether EGM users understand the meaning of RTP or its relevance to their outcomes.

The bottom line is that unlike other addictive consumptions such as alcohol (Babor, 2010) and tobacco (Chaloupka, Yurekli, & Fong, 2012), price as a concept is difficult to apply to the case of EGMs (Woolley, Livingstone, Harrigan, & Rintoul, 2013).

Common misconceptions

Many EGM users believe that if the game is operated in a fair manner, they should leave gambling venues with an amount consistent with the return to player ratio advertised—that is, 85%, 87%, or 87.5% of their stake (depending on jurisdiction).

In fact, the "price" calculation is best conceived as the deduction of the price factor (1-RTP) on average for each bet wagered (i.e., for each spin).

> **A user operating an EGM with a price of 15% will, on average, lose 15% of their wager at each spin.** The effect is cumulative. So, if a user inserts $10 and wagers $1 each spin, even if the game performs exactly as predicted (and this is extremely unlikely), the user would exhaust their funds in a little more than five minutes (at the rate of one wager every five seconds). With $5 bets, this process would occupy a little over one minute.

In a simulation of the popular game *Black Rhino*, the Productivity Commission (1999b) undertook an exercise to calculate the mean and median "time on device" with a given stake. Their calculation, based on a $30 stake, $1.50 wagers and 5-second spins, was that average time on the game before funds were expended was 13 minutes and 4 seconds, with a median time of less than 4 minutes.

The maths behind major prizes are just as stark. The Productivity Commission (1999a) developed a calculation to assess the number of spins that would be required to provide a 50% probability of winning the major prize on an EGM. Applying their calculation to the *Dolphin Treasure* game, it would require 24,703,765 spins to achieve a 50% probability (a 1 in 2 chance) of winning the major prize. Wagering a single line at 40¢ per spin at intervals of 5 seconds, this would cost nearly $1.2 million and occupy 1,429.6 days (or 3.9 years) of continuous use.

The effect of betting strategies

The betting "strategy" of users will influence time on device. (For a discussion of typical EGM wagering strategies, see "Wagering strategies", below).

If a user bets only one credit on one "line", they may experience extended time on the game compared to the above examples. However, most experienced EGM users employ a "mini-max" or similar strategy (Harrigan, Dixon, & Brown, 2015; Livingstone & Woolley, 2008), whereby they will select multiple lines (often as many as possible) and bet the minimum on each line. This means that no "winning" line will be missed. It also makes "losses disguised as wins" (see below) possible.

Price elasticity of demand

If gamblers' demand for EGM gambling were highly responsive to price—that is, if users changed their behaviour as prices rose—then the conclusion would be that EGMs had significant price elasticity. Raise the price and lower the demand.

The Productivity Commission (1999a) has noted a lack of evidence of price elasticity for gambling in general, and in particular for EGMs. But on the basis of available evidence, the Productivity Commission concluded that demand for EGMs was most likely price inelastic, because of the lack of price information and the lack of *substitutability*.

> Although in casinos alternative gambling forms, such as somewhat lower priced table games, are readily available, EGM users continue to utilise EGMs—which may cost as much as 10 times the price of a table game.
>
> Productivity Commission, 1999a
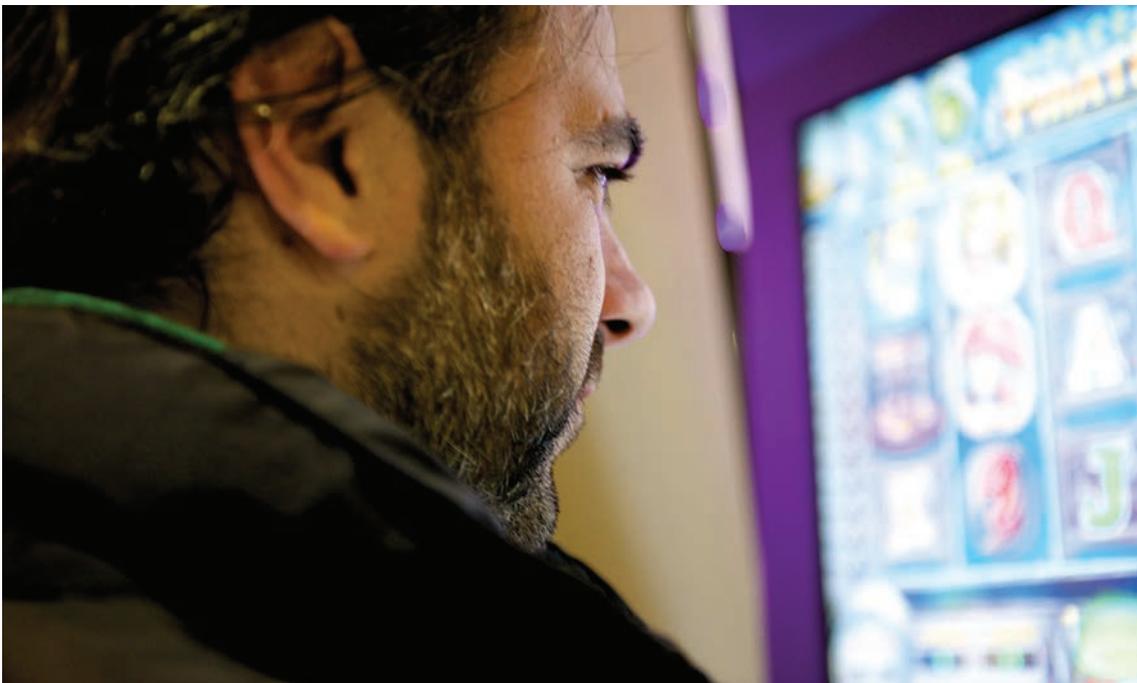
Structural characteristics of EGMs

The goal of game designers is to maximise revenue per available customer (RevPAC) and "time on device" (ToD). For the most part, designers utilise structural characteristics to do so (Schüll, 2012).

Structural characteristics define the capacity of EGMs to induce substantial expenditure in users. They may also have an addictive or habituating effect on users.

Psychological characteristics

Basic psychological characteristics underpin all EGM designs. These characteristics deliver "reinforcement" to users; render games attractive to, or popular with, users; and appear to be associated with the establishment of persistent game utilisation or addiction.

There are many such characteristics delivering game outcomes, and it is appropriate to consider them as relevant to harm minimisation interventions. All psychological characteristics are amenable to modification, given the computer-based nature of EGMs.

Reinforcement

In psychology, reinforcement means anything that increases the likelihood that a response will occur (Boundless, 2016).

Operant conditioning

Operant conditioning is a psychological concept related to the provision of an irregular, variable or random schedule of reinforcement—that is, of rewards or "prizes" (Skinner, 1953).

> It has been repeatedly demonstrated that animals (including humans) develop habitual behaviour when exposed to an **unpredictable** pattern of rewards in response to specific activities.

Operant conditioning is a key element of EGM design and is incorporated in EGM games via their "game maths": the interplay of random outcomes and the reward schedule of the game.

Variables of EGM operant conditioning

Volatility

This concept relates to the extent to which an EGM game conforms in the short term to its programmed overall (long-term) outcomes. For example, a game with a 90% return to player ratio (RTP) can achieve that outcome by providing a steady stream of small rewards, or by providing larger rewards more infrequently. The latter game would be regarded as more volatile than the former.

Frequency of rewards

Frequency of rewards is related to the volatility of a game and its prize structure. If rewards are awarded regularly, the game is likely to have a lower maximum prize, or to provide that maximum prize only very rarely; this may permit users with a fixed stake to use the game for a longer period than a more volatile game.

Structure of rewards

The structure of rewards is also related to volatility and frequency of rewards. A game with many modest rewards may have a lower or rarer jackpot than a more volatile game. However, a game with regular modest rewards may also have a large maximum reward if it does not have a spread of rewards in the middle ranges, or if that maximum reward is very rare.

Jackpots

Many games offer jackpots, which may be either stand-alone or linked. Stand-alone jackpots apply to a single machine. Linked jackpots contribute to an aggregate prize pool, which is accessible as a single jackpot for any user of a linked machine.

In either case, if the jackpot is what is known as "progressive", the game makes a pre-determined contribution to the jackpot pool, which is then paid out to the user who achieves the successful combination of symbols. The effect of this is to lower the actual return to player (RTP) to users who

use the game without achieving a jackpot payout. The user of such a game is unlikely to understand the impact of this effect.

For example, the game's base theoretical RTP may be 87%. If 5% is contributed to a linked jackpot, the base RTP for that game alone will be reduced to 82%. Stand-alone jackpots operate in a similar manner. RTP is calculated having regard to the effects of jackpot contributions.

> Progressive jackpots permit the game to portray large prizes as available, although the most likely effect is to reduce the user's "time on device" for a specific amount of money relative to a similar game without a progressive jackpot.

Some progressive jackpots may be less than completely random: that is, the probability of these events occurring may vary from time to time. This type of jackpot may arise by use of a "deterministic" algorithm which imposes some constraint on the conditions under which the jackpot may be achieved. This may involve a combination of the amount the jackpot pool contains, the number of EGMs being utilised within the linked network, or the number of bets made within a certain time period. This is in contradiction of the usual random nature of EGMs, and is another characteristic generally not well explained to EGM users.

> The parameter constraints of progressive jackpots may not be apparent to EGM users, although Hing (2007) has reported that some criminal syndicates have attempted to dominate the use of EGMs on linked networks when they believe an algorithm's conditions have been met.

The maximum prize available on a game may also be referred to as a "jackpot". However, a maximum prize jackpot is non-progressive (i.e., the size of the prize is not increased via the contributions of users), and the RTP of the game incorporates the effect of this—usually very rare—event.

Non-deterministic jackpots, like all other prizes on EGMs, have a constant probability of occurring at any time (Rockloff & Hing, 2013).

There is some evidence that jackpots influence user behaviour, including increasing expenditure and bet size (Browne et al., 2015; Crewe-Brown, Blaszczynski, & Russell, 2014).

Quantum of rewards

The maximum value of rewards on EGM games is related to volatility and reward structure. Maximum prizes in Australia are generally subject to a regulated maximum value of $10,000, although unrestricted games available in casinos may offer higher maximum prizes.

Classical conditioning

Classical conditioning, made famous by Ivan Pavlov (1927), postulates that animals, including humans, will learn to associate favourable and rewarding outcomes or events with specific physiological stimuli—for example, sounds, lights, odours and sensations. There is ample evidence that classical conditioning can be associated with any type of stimulus, and that it is as effective in humans as in other animals.

> EGM games typically signal delivery of rewards with a combination of melodies and sounds, visual displays—such as lights and colourful images—and, in some cases, messages indicating a "successful" outcome.

Such signals become associated with the achievement of a successful outcome (a reward) and deliver classical reinforcements across a range of highly stimulating audio-visual stimuli.

Messages

Messaging on EGMs is typically reinforcing. Messages displayed on the screen may congratulate the user on their "good fortune" or "luck"; they may indicate the scale of the reward (usually by an accumulating display of "win" credits); or, in some cases, they may suggest that the user is beating the odds. Congratulatory messages of this nature are not universal, but where they are displayed they provide users with a reinforcing message indicating that rewards reflect the user's luck or good fortune.

Melodies

Melodies for EGMs are typically composed for purpose and will vary to reflect the scale of the reward. A large reward will be accompanied by a lengthy melody, aligned with the game's theme. However, even small rewards are accompanied by a melody.

Typically, game melodies are upbeat, use major chords, and conclude on a rising chord structure.

Other audio effects

Some games employ sounds such as animals galloping, engines revving, tyres screeching, simulations of coins dropping into a tray, railway engine whistles or horns, or some other sound effect associated with the theme of the game. These sounds are triggered by rewards occurring in the game, including the awarding of "features" (usually "free" spins) that characterise many games.

Lighting effects

EGM lighting effects can be very spectacular and typically include flashing coloured lights on or around the periphery of the screen, waves of colour traversing the screen and so on.

Animations and graphic effects

Many games utilise animated effects on screen, for example, treasure chests opening to display jewels and gold, dolphins leaping, cars crashing through the screen, goddesses or other supernatural creatures appearing and smiling. Such effects are also invariably aligned with the theme of the game.

The achievement of some combinations of symbols triggers often spectacular visual effects focused on symbols, and these are likely to have a conditioning effect.

General structural characteristics of EGMs

Despite the modest state of knowledge around specific game characteristics (see above) there are some aspects of EGM structural characteristics for which good evidence is available. These include the effects of:

- credit insertion;
- bet size;
- display configuration;
- wagering strategies;
- features;
- near misses and losses disguised as wins.

Credit insertion

Coins, notes, Ticket-in Ticket-out (TITO), cards

Contemporary EGMs permit the insertion of either coins (generally $1 coins) or banknotes to load credits. Most Australian jurisdictions allow banknotes to be inserted into EGMs, although South Australia has not permitted the installation of banknote acceptors (BNAs) on EGMs in clubs and hotels (Australian and New Zealand National Standard Working Party, 2015). In some venues in some jurisdictions, "ticket-in ticket-out" (TITO) systems allow users to insert a ticket or slip with a printed scan code to load credits. If a user cashes out of such a machine, the TITO ticket can be inserted into another machine or "cashed out" via a cashier or terminal. 'Tokenisation' of gambling has been associated with loss of connection to actual value, and TITO systems may have a similar effect (see 'card based gambling', below).

Load up limits and note configuration

Australian jurisdictions prescribe different limits for "load up" (the amount of money that can be loaded as credits at any one time) and for denomination of notes.

NSW permits a load up of $7,500, and the insertion of all Australian banknotes. Victoria has a load up limit of $1,000, with the largest denomination note permitted being $50. In Queensland, the load up is $100, and in the ACT, NT and Tasmania it is not specified. In South Australia, the load up limit is not specified but banknotes are not permitted on EGMs in clubs and hotels. Large load up limits with high denomination banknotes permit very rapid expenditure. The Productivity Commission recommended that the load up limit for EGMs should be $20 (Productivity Commission, 2010).

Card–based gambling

Some jurisdictions in the US and elsewhere permit EGM users to load credits directly onto EGM games using a credit or EFTPOS card. This is not permitted in any Australian jurisdiction.

Victoria and NSW permit EGM venues to offer systems whereby users may load value on to a card or an account accessible via a card; the card is then inserted into a reader built into or added to the EGM (Blaszczynski & Nower, 2009; Nisbet, 2005a, 2005b, 2005c; Parke, Rigbye, & Parke, 2008). This is distinct from a pre-commitment system.

The exact implications of this system are unclear but may involve a more "abstract" approach to the cost of gambling: that is, it may allow EGM users to distance themselves from the experience of losing their money. The consequence of this may be to "facilitate spending and make it harder for people to keep track of their expenditure" (Gainsbury, Hing, Delfabbro, Dewar, King, 2015, citing Griffiths, 1995). Reduced cash handling and lower risks of robbery may also be by-products of cashless EGM gambling.

Bet size

The quantum of bet size obviously is of interest to regulators seeking to reduce harm to gamblers experiencing problems.

Maximum bet

The quantum of a maximum bet varies between Australian jurisdictions. A $5 maximum bet (that is, the most that can be wagered in one "spin") applies in Victoria, Tasmania, South Australia, and Queensland. Maximum bets of $10 can be wagered in NSW, the ACT and the NT. In casinos, however, many jurisdictions permit unrestricted maximum bets, though in some cases with the proviso that insertion of a loyalty card is required to permit this. The Productivity Commission (2010) recommended a reduction in the bet size to $1.

A 2001 study (Blaszczynski, Sharpe, & Walker) indicated that reducing the maximum bet size to $1 would reduce harm to gamblers experiencing problems while not impinging on the enjoyment of "recreational gamblers".

Minimum bet

The scale of a minimum bet is a direct function of the credit value of the game. A 1¢ credit value EGM will have a minimum bet of 1¢ where one line is bet at minimum credits. However, such a game could also permit bets up to the level of the maximum bet, depending on the number of lines used and the use of multiple credits per line. A 1¢ credit value game with 50 lines and a capacity to bet 10 credits per line will permit a $5 maximum bet. A 2¢ game with the same characteristics will permit a $10 maximum bet. See "The reality of player returns", above, for more information on different betting strategies.

Scaling up bets

Increasing the credits wagered per line is achieved by pressing the relevant button on the machine's fascia panel, or in some cases its touch screen. If "10 credits" is selected, this increases the size of the bet tenfold, and so on. Increasing the credit value of the wager also increases the potential payout, which is a multiple of the credits wagered. If the bet is increased by a specific factor, any reward from that spin is also increased by the same factor. However, the rate of losses is also increased by the same factor.

Display configuration

The display of most contemporary EGMs is via a LED or similar screen, and in many cases these incorporate touch screen characteristics. Some displays utilise large, wrap around displays incorporating curved and immersive screens, and some feature elaborate housings. However, most EGMs in hotels, clubs and casinos in Australia are currently stand-alone devices with a relatively traditional appearance, generally lined up in rows and sitting on boxes or stands that permit their operation by users standing, or more commonly sitting on high bar stools.

Spinning reels

The reels appearing on contemporary EGMs are a simulation of mechanical reels of older-style mechanical gambling machines.

The effect of reels "spinning" is an illusion generated by the game software. The outcome of the event is known immediately after the button has been pushed.

The order of reel symbols on games authorised for use in Australia must remain constant, mimicking mechanical reels. For example, if the reel displays the symbols A, B, C, … X, Y, Z, in that order,

they must always be displayed in that order. So-called "progressive games" (distinct from progressive jackpots), which are triggered by a specific set of symbols appearing on the main game, may incorporate a different order of symbols when compared to those appearing on the main game. However, these must also maintain a constant order of symbols for the duration of the "progressive game".

Weighting of reels

There is no requirement for the same number of symbols to appear on every reel, nor for the same arrangement or type of symbols to appear on each reel. Thus, a game may have four reels of 30 symbols and a final reel of 44 symbols (which occurs on the game *Dolphin Treasure*). Currently the user has no way of knowing the length of each reel. This is not generally understood by users, and is not detailed in information screens (where these are available).

Starving of reels

The winning symbols on the reels may be disproportionately placed on specific reels.

For example, *Dolphin Treasure* has one "King" symbol on the first reel, two King symbols on the second reel, four on the third, five on the fourth and three on the fifth. The effects of reel "starving" (industry nomenclature) in generating "near misses" are discussed below. Again, this is a characteristic of EGM games that users are not familiar with, and which is not described on information screens, where available.

Wagering strategies

Typical EGM wagering centres on the ability for users to lay bets on the combination of symbols appearing on one or more "lines" (rows), and in some cases "reels" (columns).

Multi-line bets

Contemporary EGMs almost invariably permit wagers to be made on multiple lines. The default single line option is the line of five symbols across the centre of the screen. The two lines above and below the centre line can also be used, as can a large array of other arrangements, some examples of which are shown in Figure 1.

In Figure 1, the first image illustrates the first three lines (1, 2 and 3) available for wagers. The second image illustrates lines 4 and 5. Both lines are V shaped. E.g., line 4 starts at the top left of the EGM display (top line of the first reel) moves through the middle line of the second reel, then the third line of the third reel, then the middle line of the fourth reel, and then the top line of the fifth reel.
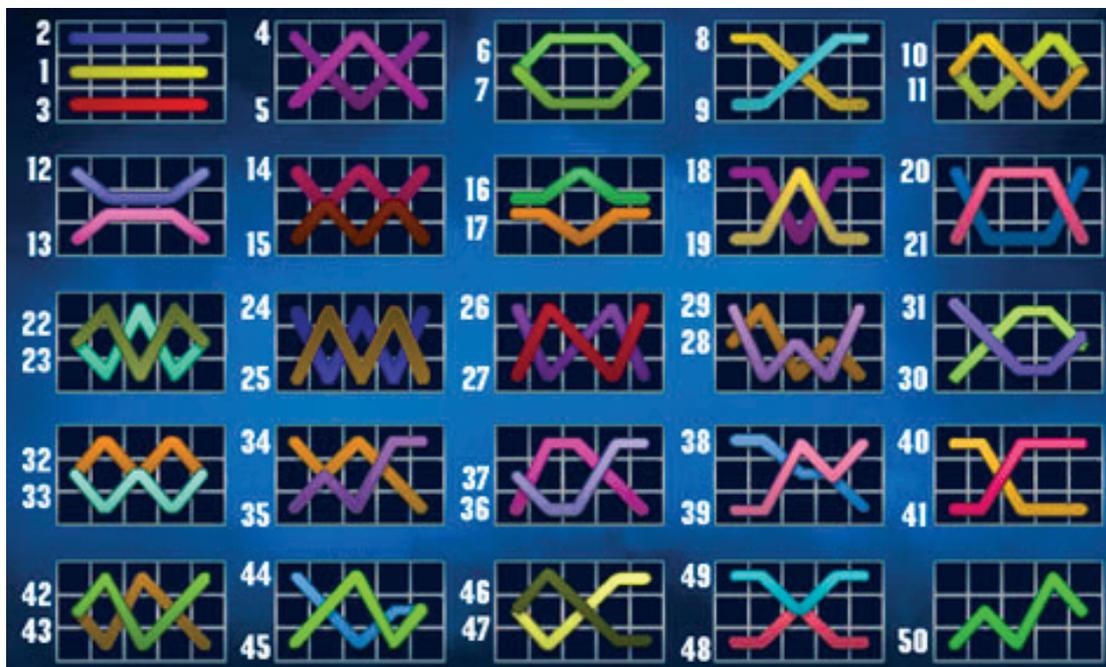

Figure 1: Multi-line configuration for a 50-line game

Source: BK media group http://www.bkmediagroup.com/blog/item/196-bet-on-your-website-don-t-gamble

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Wagers may be on a single line, on all available lines, or on some subset of the available lines.

It is common for contemporary EGMs to allow bets to be placed on up to 50 (and in some cases more) lines. Livingstone and Woolley (2008) analysed South Australian EGM game-level data, which indicated that multiline games were successful in encouraging users to wager relatively high average bets. Dr Kevin Harrigan demonstrates the way multi-line games can accelerate reinforcement in this video: <www.youtube.com/watch?v=Ms-BovQ0lSw>.

Reel betting

Reel betting differs from line betting in that the winning symbols are displayed on a combination of reels (i.e., vertically) and lines. The default combination for Aristocrat's *ReelPower* games is the first reel plus the middle line. Increasing the combinations upon which bets may be placed brings more reels and lines into play. *ReelPower* games allow up to 243 (or in some cases more) bets to be placed. The effect of this is to increase average bet sizes, and the rate of losses, quite substantially (Livingstone & Woolley, 2008).

"Features" (a.k.a. free spins)

EGM "features" are triggered by the appearance on the screen of a series of symbols, often as "scatters" (i.e., not necessarily lined up along a line in use). When the necessary number of scattered symbols appear, they trigger a feature.

How features are triggered

A feature, which is triggered by a scatter of symbols, consists of a series of "free" spins, which operate automatically once the user initiates them. In some cases, it involves a separate game or set of winning combinations. In other cases, the game is identical to that of the main game on the EGM, but rewards are multiplied—the extent of multiplication usually relating to the number of scatters that triggered the feature.

Effect on price and prize structure

The RTP of any game takes into account the effect of features, so the spins are not "free" as most users understand them to be. The cost and rewards of the feature spins is calculated into the game's outcomes and conforms overall to the game's RTP.

An EGM user who neither wins a jackpot nor major prize, nor triggers a feature, will achieve an average price of game use below the average RTP for that game, given that "deductions" from RTP are required to fund these characteristics.

For conditioning purposes, though, features provide a specific and sought-after reward, so the likely effect of features is to provide an additional reinforcement, akin to a jackpot or large win.

Near misses and losses disguised as wins

Contemporary EGMs incorporate two structural characteristics known as "near misses" and "losses disguised as wins" which both generate a form of physiological response which is similar in nature to that exhibited from a win (Dixon, Harrigan, Sandhu, Collins, & Fugelsang, 2010; Harrigan et al., 2015; Harrigan, 2008). Their effect is to add a cost-free (for the venue) reinforcement to the reward schedule of the game.

Near misses

"Near misses" involve the display of a series of symbols which are perceived to come close to providing a reward, but which do not in fact deliver this. In Australia, the deliberate engineering of near misses is prohibited (i.e., the technical standards forbid game designs from deliberately programming near misses). However, by their very nature, any EGM must sometimes produce outcomes where a winning symbol is on the wrong line for a big win. It is not possible to have a standard gaming machine with randomly determined outcomes that does not on some occasions generate near misses.

Programming for near misses

In the *Dolphin Treasure* game, the total number of symbols on each reel is not constant, and the number of King symbols varies per reel: there are fewer King symbols in the early reels (see "Starving of reels", above) and more in the later reels.

The odds of obtaining five King symbols are 1/30 x 2/30 x 4/30 x 5/30 x 3/44 = 120/35,640,000 or **1 in 297,000**.

Given that there are multiple King symbols on later reels, however, it is not particularly unusual to see a grouping of multiple King symbols on the screen, i.e., the odds of seeing a King *on the last three reels* are 1/660, and on both the third and fourth reels they are 1/45.

Such combinations will therefore occur relatively frequently. However, the game pays rewards from *left to right*, and the odds of achieving three kings *on the first three reels* (and achieving the most modest reward for King symbols, a prize of five credits) is 1/30 x 2/30 X 4/30, or **1 in 3,375**.

> The odds of achieving a substantial win are reduced by the starving of the early reels. Lines pay out from left to right: nevertheless, the appearance of King symbols in the later reels may be interpreted as a near miss by a user. This will have a reinforcing effect on the user (see below).

Losses disguised as wins

"Losses disguised as wins" (Dixon et al., 2010) is a term that refers to the possibility of winning an amount less than that wagered via a spin of an EGM.

Contemporary EGMs almost invariably offer the choice of multiple lines or, on reel betting games, "ways" of winning, which permit the user to bet on many lines.

> If the user bets 1¢ on each of the 50 lines, and one of those lines provides a modest reward (e.g., 5¢), the EGM will deliver a reinforcement via screen displays, sounds and other stimuli—even though the net result of this wager is a loss of 45¢.

Dixon et al. (2010) suggest that the consequences of this characteristic are to: 1) increase the amount staked per spin, and thus to increase the overall level of gambling revenue; and 2) deliver reinforcement at up to twice the rate possible via a single-line game.

In sum, the reinforcing effect of losses disguised as wins serves to:
1. increase expenditure per user; and
2. establish behaviour that is more difficult to extinguish than that achieved by a single-line game.

These effects are not well understood by EGM users, nor by many policy makers. However, the Queensland iteration of the Gaming Machine standards uniquely prohibits audible sounds from accompanying a 'loss disguised as a win'. The game may display the line where winning symbols occur and add the credit value to the 'win' register, however.

About the author

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Dr Charles Livingstone is a gambling researcher. His interest is in the relationship between poker machine gambling and socio-economic disadvantage and health inequity, and in the development and implementation of relevant harm minimisation policies and strategies. He has also researched the structural characteristics of poker machines and the relationship of these, and the structure of gambling systems, to the development of gambling problems. His current research is focused on mechanisms of gambling industry influence in relation to public policy, and on regulatory issues around development of best practice gambling policy.

Charles was a member (2010–11) of the Australian Government's Ministerial Expert Advisory Group on Gambling. His research has been funded by the Victorian Gambling Research Panel, the Independent Gambling Authority of South Australia, the Victorian Responsible Gambling Foundation, the Australian Research Council, local governments and primary care partnerships, the Victorian Department of Human Services, VicHealth, the Australian Institute of Family Studies, the Australian and New Zealand School of Government, UnitingCare Australia, and the Alliance for Gambling Reform Inc.

Charles is a member of the Public Health Association of Australia and provided submissions to the Productivity Commission's two inquiries into gambling (1999 and 2010), as well as to numerous state and federal government Parliamentary inquiries and to members of parliament. He is a regular contributor to public debate on the issues of gambling reform.

Appendix: Key terms

Credit – The value available for wagering on an EGM. EGMs may have credit values of 1¢, 2¢, 5¢, $1, and so on. EGMs in casinos may permit credit values of higher amounts. The credit value is the value of the minimum bet on the EGM and may be escalated by betting on multiple lines or wagering multiple credits, or both.

EGM – Electronic gambling machine. A generic name for any electronic device that permits gambling on a simulated event generated by a random number generator. Other names include slot machines and poker machines ("pokies").

Feature – Triggered by a scatter of symbols and consisting of a series of "free" spins, which operate automatically once the user initiates them.

Game maths – The intersection of a machine's reel map and pay table. Represented in a machine's PAR sheet.

Jackpot – A rare event that is triggered by a unique combination of symbols. It can apply to a single machine or to a series of linked machines with an aggregate prize pool.

PAR (sheet) – Probability accounting report. A document maintained by EGM manufacturers which shows a machine's "game maths". Australian machines' PAR sheets are not directly scrutinised or retained by Australian regulators.

Pay table – The prizes awarded for each combination of symbols appearing on a line. For example, if the random process generates three Kings, this will be mapped to the pay table to pay, e.g., five credits.

Reel – A series of strips, with symbols, that appears to spin, having its origins in older-style lever-operated machines which spun a series of physical reels.

Reel map – The number and order of symbols on each virtual reel.

RevPAC – Revenue per available customer. An industry term reflecting a design goal (maximising RevPAC) for EGM designers.

RTP – Return to player (ratio). The proportion of each wager the EGM is designed to return on average to the user. RTP represents an average deduction from the user's wager for each bet, calculated over the game cycle.

TITO – Ticket in–ticket out. A system to allow EGM users to load up a value on a terminal which provides a readable "ticket" on which the value is inscribed. When the session of use is ended, the EGM will then inscribe the value of any remaining credits onto a similar ticket, which may be redeemed at a terminal or via a cashier.

ToD – Time on device. The time spent by any given gambler on a given game. An industry term reflecting a design goal (maximising ToD) for EGM designers.

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