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I am an experienced industry professional with more than 12 years of working experience. At present I am pursuing my PhD in Design in the Department of Design, IIT Guwahati. My area of research is in determining the relation between haptic experience and game design requirements for entertainment digital games.

I graduated with a B.Tech in Mechanical Engineering from Haldia Institute of Technology, West Bengal, in 2007. After graduating I started my professional journey by joining TVS Motor Company Pvt Ltd. I worked in R&D Engines for TVS Motor Company for almost 8 years in engine transmission design and development for the three-wheeler vehicle segment. My extensive work in this domain resulted in 2 patents to my name as well.

After gaining a significant and in-depth understanding of the engineering and technical aspects of product design and development

I proceeded to do an MBA from IIM Lucknow to understand the business aspects of products and how business requirements are tied into the entire process. Post completion of my MBA I worked in Shapoorji Pallonji Group in Corporate Strategy. I was primarily involved in business strategy and business plan development for various group level projects and new product development business planning for various subsidiaries of the Shapoorji Pallonji Group.

After this corporate stint I returned to academics and became a PhD student in Department of Design where I could bring my extensive industry experience related to product development and business planning to the field of design and marry it with my long-time passion about digital games and contribute to the field of research in game design and player experience.

An exploration of how game design can contribute to sustainability

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Games have been a part of human society since times immemorial. Games have served as an avenue to relax, have fun and socialize. Though with the passage of time the way humans play games have evolved into more complex forms, the core purpose of games to provide humans with the means of entertainment and enjoyment remains unchanged. In the current era games have taken a digital form, often referred to as video games, and can be experienced easily within the comfort of our homes.

The video game industry generated a revenue of about 347 billion dollars in 2022 (*Video Games - Worldwide | Statista Market Forecast*, n.d.) and is expected to grow at a CAGR of 8.74% between 2023-27. The number of active users stood at 2.5 billion in 2022 and is expected to reach 3.1 billion users by 2027. The video game industry is also much larger than the movie industry. All these facts and figures highlight the economic potential and reach of the video game industry and the impact it has on human society. This might lead one to wonder what does the video game industry and game design have to do with sustainability.

So naturally the question does arise what relation does game design have with sustainability? This can be best explained by first walking through one of the core concepts of sustainability. In most literature related to sustainability; it has been posited that sustainability has three core pillars namely, environment, social, economic. It will be possible for design solutions to encourage movements towards sustainability by influencing any of these three pillars or all of them.

Game design has the ability to influence social behaviour. For through games, it might be possible to spread awareness about how we consume our resources and influence the behaviour of the masses. Hence, it can be inferred that game design can influence the social pillar of sustainability and can contribute towards achieving a socially sustainable behaviour. The effect of video games on social behaviour has been researched since 1994. Since 2005, the research on the effects of video gaming on social behaviour has been increasing and continues to pique the interest of researchers. As new technologies keep emerging so does video game design keep changing and hence the necessity to understand how it affects social behaviour. The existing research on game design has focused on both the positive as well as the negative aspects of video games on social behaviour. Some positive aspects identified by research include improvement in hand eye coordination, improved problem-solving abilities, better learning of different educational concepts. Likewise, some negative aspects of video games identified by research include increased propensity for violence in real life, addiction to gaming, anti-social behaviour to name a few. These examples highlight the importance that video games and game design have in influencing social behaviour and the potential it has in affecting the social pillar of sustainability as well. Furthermore, given the extensive reach and penetration that video

games have in terms of number of users its effect of the social fabric of society can be quite pronounced. In literature related to research it was observed that from 2014 onwards, the effects of game design on sustainability have gained an increased focus.

The existing research on game design and sustainability can be broadly categorized into the domains of serious games, human computer interaction (HCI), usage of sensory modalities, behaviour and motivation and psychology. In the case of serious games, the focus of game design and sustainability is on educational games. The intent in this case is that awareness about sustainability can be increased by imparting knowledge through educational games and thus influence the social behaviour pillar of sustainability. The multimodality research domain deals with three sensory modalities at present namely visual, aural and haptic. Haptic modality is one of the latest additions in the multimodal sensory experience of game design and has also been commercially deployed across multiple platforms. Apart from the above-mentioned modalities there are two other modalities namely olfactory and gustatory. However, these two modalities are still in very early stages of research and their potential for incorporation into game design and sustainability is vastly unknown. The research domains of motivation and psychology deals with effects of game design and human behaviour. The research domain of motivation mostly focuses on how to influence a more sustainable human or social behaviour through game design whereas the domain of the psychology deals with evaluating how existing game design elements affect social and personal behaviour in relation to sustainability in the given context.

Game design engages users or players by means of three forms of engagement namely cognitive engagement, emotional engagement, and behavioural engagement (Ouariachi et al., 2019). If one is to affect the social pillar of sustainability, then all three forms of engagement in game design must incorporate themes and concepts of sustainability into the game design process. The three forms of engagement coupled with concepts of sustainability can only be achieved if the game features or attributes are adequately linked to different facets of sustainability. At present the game features to consider while designing a game to meet the above linkage between sustainability and social behaviour are achievable, challenging, credible, efficacy enhancing, experiential learning, feedback-oriented, fun, identity driven, levelling up, meaningful, narrative driven, rewards driven, simulating and social (Ouariachi et al., 2019). If one is to influence social behaviour towards sustainability, then these game features must incorporate elements of the concepts of sustainability. This can be best explained by assuming a video game scenario. Let us assume a video game is made where the player is in charge of building a town or city within a natural setting, but the player will win points and level up better if the player is able to use the available resources within the game environment judiciously for developing his town or city without indulging in over consumption for rapid expansion or development. From this scenario we can see the game features of achievable, challenging, experiential learning, fun, levelling up, and reward driven being a part of the proposed video game setting. Hence from this example we can see what the game design process must undertake if it is to influence the social pillar of sustainability and bring about a behaviour change with respect to consumption patterns.

On reviewing the existing research on game design and sustainability it is observed that the use of serious games which dealt with education as one of the prevalent means of using game design to spread awareness about the concepts of sustainability (Boncu et al., 2022). The games dealt primarily with increasing awareness about climate change (Fernández Galeote et al., 2023), bio economy (Tatar et al., 2023), social sustainability (McGowan et al., 2023), management of natural resources to achieve sustainability (Strada et al., 2023) (Falk et al., 2023), ecological crisis (Heijmen & Vervoort, 2023), waste management (Hoffmann & Pfeiffer, 2022), sustainable lifestyle choices (Arboleda et al., 2022), and energy management (AlSkaif et al., 2018) to name a few. The serious games incorporated several of the above discussed game features in order to engage the users. Several of reviewed research focused on how serious education games can affect the social pillar of sustainability. While some of the research process focused on the method of the game design process and educational goals to influence social behaviour towards a path of sustainability. This gradual realization in academia about the importance of game design in influencing social behaviour for sustainability is an important aspect for achieving sustainability.

Even though game design processes and serious games, particularly educational games, are being used to influence social behaviour to achieve sustainability a lot remains to be done in this space. The reach and penetration of serious games and educational games is much lower than its entertainment counterpart. Furthermore, in cultures where games are regarded as a waste of time, educational games will be treated no differently. Hence it can be inferred that the expected impact of educational games intended for influencing social behaviour

for sustainability will not be as effective as desired. It can be suggested that popular game studios interact with academia to build strong narrative driven entertainment games which also have a strong link to sustainability concepts. This might help in a wider dissemination of the concepts sustainability and spread awareness and might have a more lasting impact on the social pillar of sustainability.

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