

BOARD #153: Work in Progress: Designing a Role Playing Game for an Astrobiology Course

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Introduction

Role-playing games (RPGs) have long captivated players with their ability to combine structured rules with boundless creativity, fostering a sense of engagement and immersion. Inspired by the pioneering work of Johan Huizinga, who emphasized the critical role of play in human culture, and contemporary game theorists like Scot Osterweil and Jane McGonigal, the integration of RPGs into educational frameworks has garnered significant interest. These games not only provide a "magic circle" where players experiment with identities and strategies but also offer a low-risk environment to hone problem-solving, collaboration, and critical thinking skills.

In this paper, we explore the development and implementation of "Mission to Europa," an innovative live-action RPG (LARPG) designed for an astrobiology course at the University of Maryland, Baltimore County (UMBC). Created as a multidisciplinary effort involving students from various fields—including Computer Science, Mechanical Engineering, Biochemistry, Creative Writing, and Media Studies—this project aimed to transform complex scientific concepts into an interactive and engaging learning experience. Grounded in frameworks such as Agile Development and informed by previous successes with the "Organic Panic!" RPG, "Mission to Europa" underscores the pedagogical potential of games to enhance both subject mastery and real-world skills.

By examining the course structure, collaborative processes, and student feedback, the aim of this study is to showcase the efficacy of RPGs as a transformative educational tool. This study not only highlights the practicalities of game design within a classroom setting but also illustrates the broader implications for fostering innovation, resilience, and teamwork in higher education.

Literature review

In his study of the play element in culture entitled *Homo Ludens*, Dutch historian Johan Huizinga writes, "It seems to me that next to *Homo Faber* [Man the Maker], and perhaps on the same level as *Homo Sapiens*, *Homo Ludens*, Man the Player, deserves a place in our nomenclature ... For many years, the conviction has grown upon me that civilization arises and unfolds in and as play." [1] Completing his first draft during the rise of Nazi Germany in 1938, Huizinga observed in his final chapter entitled "Play-Element in Contemporary Civilization" that "The elasticity of human relationships underlying the political machinery permits it to 'play', thus easing tensions which would be unendurable or dangerous- for it is the decay of humor that kills." [1]

To the extent that Man (or Woman) the Maker collaborates in teams, carries out the mission of a corporation, or builds infrastructure for a government organization, (s)he must manage power relationships and devise strategies that depend upon a comprehensive understanding of the rules - and therefore must be adept at playing a political game that maximizes the potential of her skills, ideas, and technologies to be accepted and implemented.

But what is “play” precisely? Game theorist Scot Osterweil at MIT proposes four freedoms of play:

1. freedom to experiment
2. freedom to fail, “since failure in play generally has a low cost” [2]
3. freedom to fashion identities
4. freedom of effort, or “the ability to play at our own pace, often without conscious choice” [2]

Play, in Osterweil’s view, is a “low cost” way to practice our skills, strategies, and teamwork. It is, in a sense, a beta test of survival skills: target practice, self defense, setting and making goals, finding and protecting resources, identifying allies and enemies. We can experiment with different decisions and strategies, we can try on different identities in role play, and we can take action at a pace that is comfortable for us. Thus we can prepare ourselves for the inevitable surprises and challenges that make our work so exciting and frustrating and - hopefully - valuable to others.

Game theory expert Oliver Roeder’s book “Seven Games” also draws from Huizinga’s work. He writes that games “.. offer simplified models of a dauntingly complicated world, with dynamics that we can grasp and master.” [3] Roeder builds upon Huizinga’s concept of the “magic circle” that players enter when they sit down to play, and he notes the “porousness” of that player experience : “We can take parts of ourselves into this magic circle, and we can take parts of the game back out with us.” [3]

The notion of what players bring from gameplay into their “real world” work, and the positive impact of creative solutions discovered during gameplay, is the focus of “alternative reality” game designer Jane McGonigal’s research [4]. In her book *Reality is Broken: Why Games Make Us Better and How They Can Change the World*, McGonigal offers a helpful framework for game designers. In her first chapter entitled “What exactly is a game?” McGonigal outlines four defining traits of a game:

1. The goal of the game, or what players are trying to achieve;
2. The rules which put constraints on how players can reach their goals;
3. A feedback system which lets players know how well they are progressing toward their goals (and how they compare to other players); and
4. The necessity of voluntary participation by players who willingly join the game [5].

McGonigal devotes an entire chapter to the potential of games to “eliminate” (or to reduce, at least) our fear of failure. “So how is it,” she asks, “that gamers can spend 80% of the time failing, and still love what they’re doing?” [5] She argues that in a well designed game, players are not disappointed by failure; rather, they are excited and optimistic about eventual success. But how is this relevant to real world challenges? McGonigal argues that well designed games help gamers to develop “exceptional mental toughness” [5]. In the business literature, Harvard Business School professor Amy Edmondson concludes from her research that managers who aspire to learn from failures are “thinking about failure the wrong way” - often seeking to place blame on a person or group for the failure. She urges leaders to reframe failure as “hypothesis testing” or “exploratory testing.” [6]

The literature in military education also highlights the importance of learning from failure, as well as the potential of games to engage in this type of learning. In “Assessment Strategies for Educational Wargames” Kate Kuehn highlights “the possibility of having some games play an exclusively formative role, which might allow failure and risk-taking while the subsequent assessment examines individual learning from those mistakes. In later iterations, faculty would expect not to see the same mistakes repeated” [7]. Prussian military training exercises in the 19th century known as “Kriegspiel” used miniature figures to simulate battlefield scenarios. Building upon wargames, innovators such as David Wesely introduced more open-ended scenarios in games such as “Braunstein,” allowing players to assume various roles beyond traditional military leaders. [8] One of the players who joined Wesely in his military strategy game, Dave Arneson, teamed up with game designer Gary Gygax to create the character driven RPG *Dungeons and Dragons* (D&D) in 1974. According to co-creator Gary Gygax, D&D “... sprang from an amalgam of medieval history and miniature wargames set in that period” [9].

In his introduction to the *Dungeons & Dragons Players’ Handbook*, lead designer Jeremy Crawford describes the origin of D&D in the 1970’s as “a game of make believe that fused rules with storytelling [10]” The editorial team emphasizes that “there’s no winning or losing in D&D, at least not the way those terms are usually understood. Together you and friends create an exciting story of adventurers who confront perils.” [10] As fun as this RPG has been for players since the 1970’s, do RPGs have an impact on the quality of teaching and learning in the classroom?

The Center for Innovative Teaching and Learning at Northern Illinois University outlines a variety of benefits for the use of role playing games in the college classroom, including student motivation and engagement and the development of skills used in real-world situations such as “negotiation, debate, teamwork, cooperation, [and] persuasion.” [11] In a literature review of the use of games in chemistry classrooms, one example by [Clapson et al. \(2020\)](#) traced the development of learning resources for use in a second-year materials chemistry course for

engineering students. The authors noted that “these games and activities helped students to understand the relationships between chemical structure and observable materials properties. Likewise, some activities leveraged a friendly competitive atmosphere to boost engagement and learning.” [12]

Project Origin

The idea for an astrobiology role playing game was inspired by a conversation between a UMBC astrobiology professor (Dr. Stephen Freeland) and the author of this paper (Steven McAlpine). The astrobiology professor was concerned that his current pedagogy was lecture-heavy and “boring,” and he wanted to find ways to make his course more engaging and interactive. Dr. Freeland knew that the author had been creating role playing games with his students in a writing intensive course that he had taught since 2014, and both professors wanted to try a daring experiment: could the same approach of co-designing an RPG with undergraduates, based upon a case study of nutrition in public schools, be expanded into a game design course that dedicated an entire semester to transform a complex scientific topic into an interactive role playing game?

Fliers describing the RPG design course were written and shared with other departments at the university. The course description was:

“INDS 430 *Role Playing Game Design* students will create a new astrobiology RPG entitled “Mission to Europa” in partnership with professional game designers, Goddard Space Flight Center, and astrobiologist Dr. Stephen Freeland. The *Mission to Europa* game will then be included in the Spring 2024 INDS 430 Astrobiology course led by Dr. Freeland. The Fall 2023 course will include modern and foundational works on game design as well as an analysis of our previous *Organic Panic!* RPG. The INDS 430 course is an elective for the entrepreneurship minor.”

By the time INDS 430 began in Fall 2023, undergraduates in Computer Science, Mechanical Engineering, Chemical Engineering, Psychology, Creative Writing (a double major in English and Narrative Game Design), and Media and Communication Studies had enrolled in the course. Four of the ten game designers had experience as “dungeon masters” (DM’s - basically the hosts of the game) in various Dungeons & Dragons game events, and they based the Mission to Europa mission on similar D&D game mechanics (including a crew “job application” that served as a D&D character sheet).

There were six course learning objectives, which were to:

1. Understand the design and rules of our live action RPG called “Organic Panic!”
2. Develop critical thinking skills in translating historical case studies and a NASA mission into an educational role playing game;

3. Build collaborative skills in order to work on a team with diverse expertise to create a deliverable for a client;
4. Apply Agile Development, the Scrum methods, and apps such as Slack and Trello;
5. Describe the importance of the xeno alphabet of amino acids as a frontier of science;
6. Understand the science of astrobiology.

To begin this game design project, the first week of the [course syllabus](#) explored a series of questions, including “Why are we designing an RPG, specifically a LARPG?”; “Why is the mission [focused on the moon Europa](#)?”; and “What is [NASA’s current mission to Europa](#)?” Students discussed who should join the Europa mission, and what their roles would be. Each game designer was asked to do an inventory of skills - for example, story writing, character development, programming, or experience as a D&D dungeon master. The students’ first assignment was to do a personal history of gameplay in terms of which games they played often, and what the qualities of those games were that made them so immersive. Weekly assignments included readings from analyses of games (beginning with Oliver Roeder’s book *Seven Games*) as well as reviewing game materials and videos from our previous RPG project, *Organic Panic!*

As a crash course in designing and playing an RPG for a college course, students reviewed and discussed the game rules, agenda, and other materials such as scripts for actors, and they watched videos of two different versions of the game from 2017 and 2019, noting how the different formats influenced player behaviors. Students also watched a short documentary film entitled “Cafeteria Man” that chronicles the three year journey of the movie’s “hero” who attempts to radically revise the food system for a large public school district. Students analyzed how key scenes in the movie were replicated and gamified for *Organic Panic!* Students also discussed where they saw Osterweil’s four freedoms of play framework applied in the game. Of all of the game theory readings, Osterweil’s framework was by far the most helpful for RPG design choices.

Game Design Project Management

To organize the content of the *Mission to Europa* RPG, students created two Trello boards: the Mission to Europa Development Tracker, which allowed all three groups, two professors, and the graduate TA to see what each of the three groups was working on (see Figure 1 below). The columns were: Milestones/Upcoming Dates, Quest Design, Player Classes/Roles, Actors/NPC’s, Game Mechanics/Puzzles, and Visual/Audio media. This was helpful for the first half of the semester, but once the series of RPG events became clear, we needed a second Trello board entitled “MTE Storyboard.” Students created six event columns (see Figure 2 below): Event 1 Role Selection, where our “Tech Bro CEO” actor issued a Call to Adventure to the astrobiology students, and asked “Legal Counsel” (an RPG designer/actor) to hand out the job applications (character sheets).

Event 2 Mission Brief and Training, where the ship layout was revealed in three levels or tabletop maps, and an actor who works as a professional game designer described the importance of the mission to Europa in a prerecorded video.

Event 3 Liftoff and Travel, where the crew were presented with a variety of minigames to prepare for landing on Europa, engineering challenges, medical emergencies, fire drills and other contingencies.

Event 4 Enter Europa's Orbit, where crew needed to collaboratively make a "best landing area" decision based on risks and rewards of landing near an access area to water.

Event 5A Landing Craft and 5B Mothership were designed to be run simultaneously with two AI actors guiding each team. This is the event where samples were gathered by the landing team, and ice buckets with organic and inorganic material were placed in the landing area for collection.

Event 6 Return to Mothership was designed but not played. In this scenario (for a larger course enrollment), teams would switch, allowing a second group of players to collect and analyze samples.

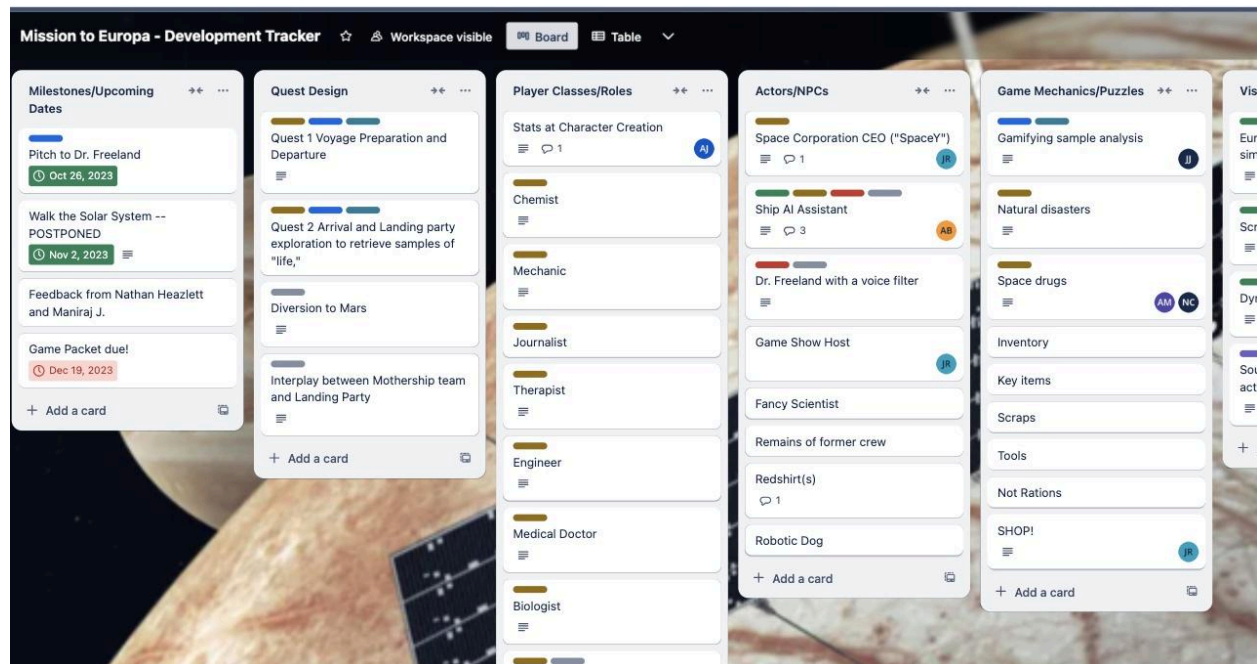


Figure 1: Mission to Europa Development Trello Board

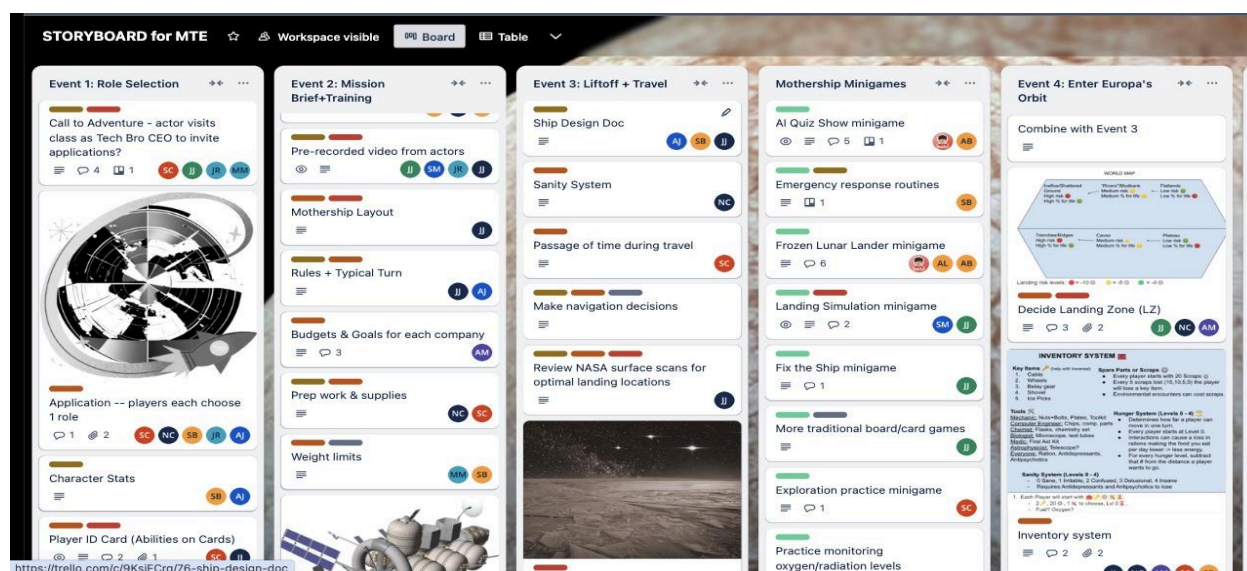


Figure 2: Mission to Europa Storyboard

The ability to assign tasks to each RPG design student and to link documents, images, and sound files was a great resource in Trello. The professors could see where content was being created, and where content had not been created, for a “dashboard” of game design status.

Having created the content, the RPG team faced some logistical challenges: how would the “dungeon master” run the game in the classroom without breaking immersion (i.e. what role could a DM play in the NASA game environment the team had just created)? Where would the professor be during the play of the game, and what role would he play? How would one of the designer /actors communicate with the players as an AI ship’s computer character?

The design team decided that the DM would act as legal counsel to the CEO of the company hired by NASA to build the spaceship. This made sense, as the legal counsel would naturally be the rules expert in the room. The classroom included a Huddlecam and conference speakers, and we had figured out how to use Zoom during COVID, so the AI ship’s computer actor sat with Dr. Freeland in his office to interact with players remotely and to answer any questions the players would have. The RPG team projected various media clips they had created on the classroom projector screen, and our “Dr. Fritz Steely” scientist actor officially kicked off the adventure with his inspiring pre-recorded message, which included these memorable lines: *“My 50 years in astrobiology have all led up to this point. Now... the only thing left to do is to physically go out there and witness it all for ourselves. Looking from our vantage point can only go so far!”*

The Astrobiology course

In the Spring 2024 INDS 430 Astrobiology course, nine astrobiology students then embarked on a manned mission to gather water samples from beneath the icy surface of Jupiter’s moon

Europa. They were challenged to select supplies and testing equipment for the spaceship, to engage in training exercises during the voyage to Europa, to deal with various emergency scenarios, to decide on the best landing site on Europa, and to gather and analyze samples for amino acid (or xeno amino acid) content. The final event of the RPG - analysis of samples gathered by players in our landing simulation - served as a final exam for the astrobiology students.

The final exam continued the game environment as the exam instructions referenced our fictitious space agency ISAA:

“Briefing from Earth:

Ship’s crew, you have successfully taken two samples of ice from Europa in which we hope to identify at least one species of alien life. For reasons we prefer not to discuss, our company believes there exists enormous commercial potential if we can successfully bring back to Earth a xeno-biological sample for further biotechnological characterization and development. In particular we are interested in xenoproteins. In related news, we have recently become aware of a specific, novel technological development at our rival company SynBioTech which would significantly expedite our proposed route to commercialization. It would cost us approximately \$16 billion to launch an aggressive takeover of this company, however the window of opportunity to launch the takeover is 90 minutes from the time at which you receive this briefing, and the takeover would be a waste of money if you do not in fact have a sample of xenobiology that is using xenoproteins.

Our government partner ISAA would like verification that your analyses of the specimens you collected were done according to regulated standards. We therefore have to be correct in our assessment of the opportunity here. We further regret that in order to avoid significantly inflating the price of the takeover, our legal team must be able to demonstrate plausibly that you (not we) designed and conducted the analyses which identified xenoproteins. We are therefore able to offer you clues, but we require that you create a presentation to ISAA about how you would analyze these two samples. Given that it will take ~45 minutes for a transmission to reach Earth we ask that you attempt to create a presentation to describe and explain your experimental protocol within the next 45 minutes. Please use the media camera on the Bridge.”

The students performed well on the exam, encouraging Dr. Freeland to offer the course again in Spring 2025.

At the end of their semester, astrobiology students offered feedback to the game design students, game design professor, and the astrobiology professor. Three important takeaways will inform the next iteration of the *Mission to Europa* RPG design:

1. Provide clearer instructions and guidance for future expeditions.

2. Improve communication between the inside [the classroom, which was the team on the Mothership] and outside [the lunar landing party who physically left the building to find samples] groups during expeditions.
3. Implement a point system and other features in future iterations of the game.

Now, in February of 2025, a new team of game design students is incorporating this feedback into Version 2.0 of Mission to Europa, and both the RPG design course and the astrobiology course have been scheduled in the same time slot. This allows game designers to attend lectures in the first half of the course, and in the second half of the course these designers will become game masters and actors who run the RPG that they have redesigned.

Measuring impact on student learning

Dr. Freeland plans to teach the first seven weeks of his course in a traditional lecture format, then the Mission to Europa RPG will begin after Spring Break and run for six weeks. An exam will be given in the seventh week after spring break. Dr. Freeland has designed the following exam strategy to measure students' understanding of astrobiology:

1. Astrobiology students take the exam during their first class meeting and then again in week seven as a midterm, in order to measure whether the "traditional course" helped them to advance their understanding of astrobiology.
2. By taking the exam a third time at the end of semester, Dr. Freeland will attempt to measure whether the game helped students to understand astrobiology and scientific exploration more deeply.

Dr. Freeland and his PhD student, Dr. Sean Brown, aim to be "more creative" with the final (third) exam - "perhaps along the line of questions that ask for reflection on what they now understand that they didn't at mid term." [email communication 02/21/25]

Finally, we will conduct semi-structured exit interviews with each player/student to ask them to compare the first and second half of the semester in terms of their understanding, motivation to learn, ability to collaborate, and opportunities to apply their knowledge to various challenges posed by the RPG.

Opportunities for game based engineering and entrepreneurship

In the Fall of 2024, two mechanical engineering teams of students at UMBC who enrolled in ENME 444 *Mechanical Engineering Systems Design* took on the challenge of designing and building a movable tabletop and landing gantry for the Mission to Europa RPG. Engineering students were given an overview of the RPG, and then were given detailed system requirements for Event 5 of the RPG (where players land a small lunar craft on Europa, assess the risks of ice

instability and seismic events, and collect water samples). The system requirements included the need for the game master to simulate ice instability by tilting the slippery surface of the table. The team also analyzed NASA images of the surface, and the team 3D printed various ice formations to provide obstacles and further realism for the challenge of selecting a safe landing site. The second team designed and built a movable landing gantry to enable players to lower a small lunar craft anywhere onto the tabletop (see Figure 3 Europa tabletop engineering team Fall 2024).

With the tabletop games market estimated to reach \$5.3 billion globally by 2035 [13], the tabletop design has potential market value that could be explored in a new “tech entrepreneurship” course to be offered in the Fall of 2025.



Figure 3: Europa tabletop engineering team Fall 2024

Conclusion

One of the most valuable learning outcomes of the RPG design course was a deeper understanding of the challenges of project management. Students needed to hold each other accountable for delivering their piece of the game on time, and to make sure that teams were aware of how their work supported other teams. Using the Trello app to organize tasks allowed

students to see the “whole playing field” - if students took the time to read through the digital cards and links, and if the instructor invested class time in reviewing updates on the Trello board. As players noted in their feedback, game mechanics (how players can earn points, how game managers can keep track of those points as the game play unfolds, and how those points can be displayed quickly on a scoreboard) proved to be the most challenging aspect to implement in Version 1.0.

Whatever the shortcomings of our beta version of this game, the fact that the RPG succeeded in immersing players in an introduction to the search for life on other worlds stands as a testament to the power of collaborative multidisciplinary design work at the undergraduate level. Given the right balance of structure and creative constraints¹ [14], undergraduates are capable of innovative game design that intensifies the learning experience in a college classroom.

Future directions

Game designers will need to spend time in the Spring 2025 semester writing clear and concise instructions for how to play the game, and perhaps to think of “learn as you go” support as the game progresses. Software such as CATME (the Comprehensive Assessment of Team Member Effectiveness) - a group assessment tool developed at Purdue University - could be helpful to assess student performance in RPG design teams. Ultimately the goal of this project is to develop *Mission to Europa* game materials to the point where any teacher of astrobiology could use this RPG in their classroom.

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¹ Perhaps one of the greatest examples of creative constraints comes from the composer and lyricist Stephen Sondheim: “I like writing within parameters,” Sondheim says. “... If you tell me to write a love song tonight, I’d have a lot of trouble. But if you tell me to write a love song about a girl with a red dress who goes into a bar and is on her fifth martini and is falling off her chair, that’s a lot easier and it makes me free to say anything I want.”

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