I recently read Annalee Newitz's debut sci-fi novel, _Autonomous._ The page-turning book follows the story of Jack, an anti-patent scientist turned drug pirate, and the human/robot team hot on her trail after one of her latest drug hacks goes terribly wrong. Newitz's novel, which takes place in the year 2144, is packed full of evolved technologies that are only in their infancy now. For instance, people use biohacking to increase their productivity and make fashion statements (like growing flowers out their hands); and autonomous robots work alongside professionals in the military and hospitals. She also delves into potential future social issues like ownership and human rights for robots.

In this exciting interview we discuss biohacking, robot/human relationships, and the future of warfare. She also gives some great book and podcast recommendations for further development!

Joe: One of the central ideas your book revolves around is biohacking. Where is the science on this now and where do you think we will be with biohacking in the coming decades?

Annalee: Right now we're in the very early stages of biohacking, though of course we have been breeding animals and plants for millennia (sometimes I call farming "slow biohacking"). Scientists are now able to engineer very simple organs, like bladders. Tissue engineering has allowed us to grow skin, muscles, and bones–and even to create hamburgers from a petri dish, which apparently taste OK.

We're starting to have a map of the human proteome and the microbiome, which represent a major leveling-up from the genome! Understanding the structure and function of proteins and microbes that live in our organs will help us understand how diseases progress and what factors impact our health. At the same time, we're developing better computer models of chemical and molecular behavior in our bodies, which will help us discover new drugs more quickly.

So if you add all this stuff together–from tissue engineering and microbiome discovery to sophisticated computer models–you are looking at a future where we can potentially print out new bones or new medicines for people who need them. We're on the cusp of a time when we might be able to fix our bodies as easily as we can fix cars.

Joe: Another theme you touch on is the relationship between humans and robots. I think this is an interesting idea because everyone I know who has a Roomba, has named it, and refers to it by their name. How do you see this relationship evolving as we continue to advance AI?

Annalee: I think humans will continue to feel like their robots are living creatures, even though intellectually most of us know they aren't. In my novel, I wanted to explore what human-equivalent robots would think of us. If they ever achieve human levels of intelligence (emotional and otherwise), what will they make of how we've treated them? Will they be annoyed that we named our Roombas? Will they love humans in the same way humans love them? What kinds of misunderstandings will arise when humans try to befriend robots? That's why one of the main human/robot relationships in my novel is so complicated and awkward, even though it's also full of love. Neither the robot nor the human really understand each other, so they just fumble along trying to understand each other's reactions.

Joe: Since most of my readers are military, how do you see artificial intelligence shaping the future of warfare?

Annalee: I think the military will be dealing with a lot of experimental technologies that

sound great on paper, but may not work very well in practice. Autonomous robots and weapons could be a major advantage–except that when they fail, they become friendly fire machines. That said, AI and machine learning are already being used to help with targeting, piloting, and flight training. These are great applications, as long as there's a human in the loop. Machine learning is also a great help if you're working with remote sensor networks, trying to figure out the difference between tanks and civilian vehicles, or troops and animals (or friendlies and adversaries). To reiterate, however, I think a human always has to be in the picture with these technologies. AI is a good tool, but shouldn't be making decisions on its own.

The other thing that I think is certain is that the military will absolutely be on the forefront when it comes to using AI. Soldiers often have to cope with bugs and mechanical failures literally on the front lines, and my suspicion is that many of the most important improvements to automation will come from military folks getting hands-on experience with the best and the worst of AI-augmented tech.

Joe: What do you think are some other emerging technologies that we should keep our eyes on?

Annalee: The technology I'm most excited about is self-driving cars. When I talk to engineers working in that space, I hear two stories. One: Self-driving cars are already here and we just need to cut through the red tape to get them on the road! Two: Self-driving cars are impossible and will never work because we still can't train an algorithm to understand the difference between a paper bag floating down the road and a child stumbling into the street! So … splitting the difference, I suspect we'll see them in the next 10-20 years. I really love the idea of autonomous cars that the elderly and disabled can use, to give them a greater sense of freedom.

There are two other kinds of tech I find fascinating, and that I think could really change our lives substantially. One is a category of material that's called "self healing." That can mean anything from glass that seals itself up after a bullet makes a hole in it, to concrete pillars under a bridge that repair their own cracks. There are also self-healing sealants and paints. The idea would be to have infrastructure that takes care of itself in a limited way, to prevent disasters. The other tech is bendable electronics. Basically, this means circuit boards that can bend like rubber, or like skin. You could have a circuit board in your jacket, or stuck to your skin. Basically it would mean that anything could become a computer or at least an internet-enabled object. The result of these two kinds of tech might be as humble as a childproof rubber ducky that talks. Or it might be a ship that repairs its own hull and sends

updates about its status to the captain's smart tattoo.

Joe: You've written articles on everything from technology to mass extinction at publications such as Wired Magazine, The Atlantic, and the Washington Post, what made you decide to write a science fiction novel?

Annalee: To be totally honest, I wanted to tell stories about science and technology without worrying about journalistic ethics. One of the journalist's most important goals is to present information that's as uncolored as possible by bias. In practice, this means that you have to contact everyone involved in a story to get their perspectives, or their reactions to other people's perspectives. I value this aspect of journalism a lot, but the reality is that it can be exhausting and ultimately frustrating. There are a lot of things that people will tell you are true off the record, but refuse to say on the record. Plus, you see a lot of things in the course of reporting a story that are disturbing or wonderful that you can't write about because there are real human beings whose lives will be affected by what you write in a major newspaper or magazine. So you keep quiet about what you know. In fiction, however, I can say whatever I want and nobody gets hurt. I can be biased! It's pretty liberating.

The funny part was that after I wrote a novel where I was totally unconstrained by journalistic ethics, I was really eager to get back to nonfiction. I wanted to tell the truth again, with all the difficulties that entails. So I'm currently working on a nonfiction book as well as my next novel.

Joe: Your book has made me even more interested in future and nascent technologies. What podcasts, articles, or books would your recommend so that I can keep learning more?

Annalee: There's a ton of great stuff out there. When it comes to podcasts, I recommend Rose Eveleth's futurist show *Flash Forward,* as well as Marketplace Tech for current tech news. I also like *Reply All.* I know this will sound weird, but I learn a lot about the future by studying history. Mike Duncan's podcast *The History of Rome* is superlative. It's a great overview of the origins of democracy and modern warfare in ancient Rome, and he has a wonderful, dry sense of humor.

As for books, I'm going to recommend a bunch of science fiction! Ramez Naam's *Nexus* is a great look at the future of biotech, featuring drugs that create brain-computer interfaces and kickass Buddhist monks (among many other things). Malka Older's *Infomocracy* is a thriller about a near-future global democracy, managed entirely with a super advanced version of the internet, that's threatened by a mysterious authoritarian takeover. Ann

Leckie's novel *Ancillary Justice* is about the last remaining remnant of a hive mind AI that controlled a warship, trying to get revenge for a war crime that destroyed one of its of most beloved officers. Neal Stephenson's thriller *Reamde* is a near-future spy scenario that involves cryptocurrency, an honorable Russian mobster, crappy terrorists, and a 100-page gunfight that is one of the most amazing things I've ever read. Finally, Martha Wells' novella "All Systems Red" (part of the Murderbot Diaries, a great new series) is the action-packed story of an extremely sarcastic security robot who is rented to mining companies and has to deal with annoying civilian stupidity as well as the usual corporate corruption. I love sarcastic robots, and this one is both technically and psychologically fascinating.

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