MCNP for engineers - A walkthrough on how to use it, get results, and what it all means to a fulfilling life

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1 Preface

1.1 Who is this walkthrough for?

Advanced undergraduate students and graduate students in any nuclear engineering curriculum. Students should know -

- Basic nuclear physics; e.g., cross sections
- Interactions of neutrons and photons with matter
- Shielding, dose rates
- Four/six factor formula; e.g., what k_{EFF} is,
- How a nuclear reactor works
- Solving for buckling
- Neutron diffusion

Just about every nuclear engineering department has this course. Typically, the Larmarsh or Duderstadt textbooks are used mostly. Sometimes the Shultis textbook is used. It's usually one of the first classes taken prior to the higher-level nuclear engineering courses. However, this course provides all you need to know to run and understand MCNP. I happen to teach this course. I use Lamarsh with Shultis as a reference. I happend to use Lamarsh because that was the textbook when I first took this kind of course. There really is no argument for one over the other.

What is MCNP?
Your best friend. Your greatest nemesis. MCNP is a contradiction. It will make you suffer, but it will open doors and present new opportunities.

MCNP is a computational tool - that means you're not coding *per se*. You set up the input file that the code will read and then execute. MCNP tracks neutrons and photons for specified geometries and produces a wealth of resulting data. That seems simple. It's not. With a little guidance, effective modeling with MCNP is achievable.

Why is MCNP so important?
It's not that necessarily MCNP itself is so important. Neutronics modeling is. We can't design any reactor without knowing where the neutrons are going and what they're going to do when they get there. MCNP happens to be the first neutronics computational tool. (They literally used punch cards.) All other tools are benchmarked against MCNP.

Not everyone is going to be a neutronics expert. For those that want to be, mastering MCNP makes it far easier to learn other neutronics codes, like Serpent. Any facility with MCNP provides a fundamental basis for a career in nuclear engineering. Frankly, if you're a graduate student, you're looking for internships. You may not really care what you're going to do; you just want a good position for your CV and a chance to network for future career development. Absolutely nothing wrong with that. On more than one occasion, I have had a researcher come up to me and ask 'Do you know any of the students that know MCNP? I have some money for an intern this summer, but I need someone to step in and get right going.' I intend for this walkthrough to give you the skills to step right in and get going.

Learning MCNP will also lend to transferrable skills. Whether it is good coding practices, geometric modeling, or just developing engineering judgement, this will lead to success in higher endeavors.

Motivation - Do we *really* need another 'How to use MCNP'?

Course supplement

Don't read this if you don't want to. I'm not losing sleep over it. Due to the virus sweeping the nation in 2020, over the summer, I decided I needed to take the time to prepare my fall course with the contingency for shifting to online delivery. I've taught the course since 2015, so I know the material, have all the slides and assignments, etc., already prepared. This is part of that effort. Students should be able to follow this on their own and learn how to use MCNP.