Modelling flow-induced vibrations of gates in hydraulic structures

Erdbrink, C.D.

Publication date
2014

Postscript

Breaking with the tradition of ending the thesis with a sentimental review of the PhD as an irreversible coming-of-age type of journey, I will give a short overview of the events that led me to starting a PhD, some subjective reflections on the work and a few statements of gratitude.

My first taste of science was during my Master project at Delft University – a field experiment in the river Spree near Berlin. After graduation I worked for two and a half years at Deltares in Delft, a non-profit water institute for research and engineering consultancy. There it was possible to add laboratory experiments and numerical modelling (CFD) to my fluid dynamics portfolio, and I started working on weirs and navigation locks. The gate vibration experiment in April 2011 gave me the idea that it would be nice to have more time for research. The progress towards finding a suitable PhD project was initially slow; until I read about Peter Sloots project in Russia and got in contact with him. Combining a topic from hydraulic engineering from first-hand practice with computational science methods, some of them completely new to be, turned out to be as great a plan as I had envisioned. The adventurous extra dimension of course came from having Saint Petersburg as my home town for three years. This fulfilled the wish of spending more time in this great city which I had visited on a short holiday two years earlier.

Let me share a few thoughts on the research work. For me it has always been clear that things become more interesting and valuable when different disciplines meet. Ideas from separate worlds that are trivial in their original contexts can unexpectedly become pregnant with new meaning and impact. This is how creativity is awarded. Sometimes, though, it seems that with it comes a *curse of multi-disciplinarity*: in evaluating multi-disciplinary research, experts from different fields each isolate and critically assess one aspect of the work and then conclude that it does not contribute much to their particular field. Instead, it would be better to judge the combined work as a whole by looking at the overall added value and the validity of the application. At the end of the day, the two driving forces of science, rigour and originality, need to be balanced somehow. But originality thrives best in faraway wastelands, while rigour is rooted in highly cultivated grounds. The challenge for the scientist and especially for the budget managers and policy makers is to recognise and respect this. Research, including PhD projects, can only be successful if, on the planned route to X, it is allowed to try a side path Y and there is time to get lost in a dark alley Z. Once arrived and settled in X, looking back on the journey, it often turns out that a small thing found halfway between Y and Z is actually the most valuable result. This is captured by the nice-sounding term *collateral knowledge*.

For me, the addition of evolutionary computing brought new energy to the project around the notorious halfway point – I thank Peter for bringing this topic to my attention. A substantial amount of work went into genetic programming, and although this did not make it into the thesis, it was great fun and sparked new ideas. What I found was that a danger in the computational sciences is to devise a new method (algorithm), present it without testing

it to different problems and without comparing it to existing methods and forget to give feedback to the application field (as also mentioned by Wagstaff, 2012). On the other hand, a danger in (hydraulic) engineering is to solve real-world problems exclusively from experience and fail to make connections with universal theories. The cure to both dangers is generally to look beyond the detailed activity that is central to your work, realise that it is good to zoom out regularly and train yourself in switching between a concrete and abstract focus.

Comparing the validity and accuracy of physical experiments (in the lab or in situ) with numerical experiments (in silico) is a common activity that can easily give endless cliché discussions. Researchers typically choose sides early in life and are not even aware of the prejudices they hold against the opposite paradigm. In the context of this thesis it hardly requires explanation why it is useless to speak about physical and numerical modelling as if one would be better, more accurate or cheaper than the other. A possible way to unite quality control of all types of experiments is to think of validation as a process of critical feedback in which data hold a central place – compare Section 3.2. The value of such frameworks is to support and motivate choices when setting up new models and model applications. However, using too general rules and philosophies will make it meaningless in terms of practical use. Finally, I would like to point out two phenomena from personal experience that always set off warning bells. The first is *reasoning against nature*, this happens when someone says that measurements nicely line up with numerical predictions from theory or that the measurements are inaccurate because they are too far off. It is not nature that does or doesn't comply with theory, but the theory that describes parts of nature well or not so well under certain conditions. It can be the case that those conditions are not easily matched by the (physical or numerical) experiment, but this is not nature's fault. There are many subtle variations on this. The second phenomenon is the creation of *computation-only realities*, this occurs when initial numerical results show such appealing properties that the computations are proceeded, expanded and trusted without checking the overlap with the (physical, biological, etc.) realm that they try to represent. In extreme cases, these endeavours create a whole world of beauty and elegance, which can be insightful in many different ways, but these ought not to lure us into thinking that the results have comparable meanings observable outside of the computational realm.

Now it's time to thank all the people who helped me, starting with my parents who supported me in every possible way; especially the smooth transitions between Russia and The Netherlands would have never been possible without you. I owe a great thanks of course to Peter Sloot, without whom I would probably still be writing research proposals for Dutch research funds. You made it possible for me to take an inspirational free dive into computational science and exchange the predictable world of planning, preparations and discussions for an unforgettable Russian life. Next up is of course Valeria, you were a great and tireless supervisor for me, who always had swift replies and practical solutions that resulted in making all deadlines. I also want to say a big thanks to Deltares, and in particular the Harbour Coastal Offshore group of Klaas Jan Bos, for supporting me throughout the PhD period. I am grateful that the lifeline always remained intact, even though I visited Delft only a handful of times. Hopefully the work has relevance for future projects and applied research. A special thanks goes to Tom Jongeling, a rare gate vibrations specialist who retired from work during my PhD. Although we did not have contact after I left Delft, I am

sure you will find in this work familiar basic ideas and principles that you taught me. Unknowingly at the time, experiences from projects that we work on together became cornerstones of some of my papers and chapters in this thesis.

At ITMO University my thanks first of all go out to Alexander Valerevich for allowing me into his department as the first foreigner, giving me the freedom to do my research independently and giving me the trust to continue my work all the way until the defence. I had a good and productive time at НИИ НКТ. My teaching experience and our trips to conferences in Amsterdam and Australia were all quite special; it felt strange to leave after three years. Of course I thank Vitya, for surviving all this time on the same four square meters of windowless office space with me, where no oxygen molecules were allowed in, only liters of instant coffee. Our common dedication to anti-mainstream music resulted in nice playlists, The Caretaker and Autechre ended up as my all-time favourites. Anna, thank you for the good times, especially the epic New Year and skiing trip to Siberia which is impossible to ever forget. Also I have good memories of the time Louis was working at ITMO, your enthusiasm for science works very contagious and I wish you good luck with your PhD (not that you need it). In short, I will cherish good memories of the entire ITMO 'kollektiv'. Я буду скучать по всем вам!

I spent the summer of 2013 at the Science Park of the University of Amsterdam, where I had a nice time in the Computational Science (SCS) group: Paula, Rick, Kees, Mike, Guusje, Brecht and the rest, I wish you all the best! Thanks to Bibi and Trudie for being well-behaved house mates in the capital's presidential area during that summer. Another Amsterdam citizen whom I shall not forget to thank is Jacques (Sjaak), in the end you convinced me to do a PhD. In my home town of The Hague I owe more than they realise to Floris (Frits) and HJ for letting me dump a pile of boxes into your homes, "I promise to pick them up really soon".

Returning again to Russia, I want to thank Andrei for the flexibility in housing me right in the center of the city for quite some time. Then there are too many dear friends I met in Piter, an extremely incomplete shortlist: Kostya, Dasha (2x), Ksyusha, Marina, Rita & Dima, Guzel, Julia, Johan & Ksenia, Lodewijk, Sasha 'from Russia', Lily, Gia and Diana – I plan to meet all of you in the future. I also want to congratulate Natalia and Alexander with their PhD, well done! I finish by thanking Lucas for his help on the cover design. And last but certainly not least I thank Louis and Annebeth for being my paranymphs!