
Education and Training in the area of HPC

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Introduction

Although HPC and its high end ‘supercomputing’ facet remains a key driver, the very concept of computing has changed dramatically in recent years. Computing infrastructures are interfacing and interacting with data-generating devices located at the Edge (sensors, social networks, precision medicine, large scientific experiments, smart factories, digital manufacturing connected platforms) in a ubiquitous infrastructure, which can be called the “Digital Continuum”, blurring the traditional categories¹. Looking for a job knowing ‘only’ HPC or ‘only’ Big Data or ‘only’ AI, and having only sharp technical skills, may not any longer be enough for a perspective employer.

The HPC education needs for public and private stakeholder organisations are manifold, and can be seen as a highly dimensional problem:

- in “space” – the diversity of stakeholders and the value chain different tiers spans:
 - o Public Research: public entities/research organisations and academia, R&D in technology, applications
 - o Infrastructures and services: computing centres dealing with “ops” (operations) but also some “apps” (applications) aspects, endorsing support and services
 - o Uses and users: user communities in public research, advanced industrial users
 - o Private companies: from supply to use, from very small to very large one offering some HPC related value (technology supply, services, ISVs, consulting and engineering...)
- in “time”- the phases of career and education timelines and needs span:
 - o Initial training
 - o Short basic or advanced trainings for practitioners (use of computing centres & community codes, programming and optimisation techniques...)
 - o Deeper, targeted on the job training (with ad hoc certifications if not delivering an explicit extra graduation such as an MBA)

ETP4HPC general recommendations

- o Take into account **computational and computer science skills** in a complementary way for **initial HPC training**, ensuring the acquisition of enough technical and scientific foundations to accommodate regular updates along a **lifelong career** – nobody can be a universal expert, but a mix of building blocks with major/minor deep dives can make up a Masters level graduation opening academic and/or industrial career paths; e.g. a ‘major’ specialisation in modelling and simulation

¹ Reference: ETP4HPC TransContinuum Initiative

- should not ignore HPC hardware architectures and parallel programming (and the other way round); 'co-design' spirit and awareness must be developed.
- Mix the classroom (learn the basics, e.g. 50%), R&D (test new ideas) and experience the field (implement these ideas) via initial training and related internships; involve industry experts in curriculae definition, in teaching.
 - HPC training has to pick up from, and build upon a selection of **general IT skills**, conversely best breed HPC education can **trickle down to wider, mainstream IT sectors**.
 - Acquisition of **non-technical and soft skills** (business development, legal aspects and regulations, IP management, etc.) can be built after some job experience, but initial training should at least develop awareness on these aspects.
 - Conversely, teaching of HPC/Cloud/AI in MBA programmes should be promoted, so as to **offer industry business leaders with "soft" skills for implementation & management better connected to technical staff with "hard" skills** for more specialist tasks. A syllabus for industry would include (i) Business benefits of HPC/Cloud/AI (ii) Procurement of HPC/Cloud/AI services (iii) Benchmarking & acceptance (iv) User management and access policies (v) Horizon scanning, (vi) Change management and (vii) Industry case studies. In short, industry leaders need a programme that fast tracks the development of skills possessed by a National HPC Centre Director.
 - **HPC Mentoring actions** could also be developed for non HPC specialists to become more aware of HPC approaches and benefits (business developers, managers) via personal induction and e-learning tools and programme demonstrations related to business profit growth.
 - Develop agile, fast and tailored HPC training service targeted to business customer's project development staff.
 - Develop general models and tools to accelerate the project for the business customer - paid service or SHAPE-like programme.

"HPC education" cannot cover all in one curriculum. Industry, research and data centre will need to hire into 4 main categories, which can be a basis to define curricula flavours, without making them rigid silos:

- **computer infrastructure designers**: how to build a whole system from most innovative parts, getting the best ROI, data security
- **complex HPC and HPDA installations administrators**: cost containing, preventive maintenance, green computing
- **HPC Software specialists**: performance, portability, reproducibility, but also data management and security
- **data analysts, scientists, engineers in many application areas**, trained in HPC "thinking"

ETP4HPC can contribute to more actively involving companies but also its public research members in developing such principles.

ETP4HPC recommendations on mobility and traineeship

HPC Europa programmes organised the **circulation of students and young researchers between EU countries** and a group of supercomputing centres. The programme endorsed expenses for the people and the hosting entities for the mobility period.

A generalisation of extending such a programme model to companies could be considered. Of course the profile and size of the companies able to welcome e.g. a Masters level intern might vary considerably, as well as their expectations and constraints. A challenging objective could be to make such a programme attractive and lean in particular for small companies with limited capacities to handle such internships, which would otherwise not consider such options: and/or attract students who may otherwise not consider an internship in a company (small or large) as their first option. The internship induction could be speeded up by lean HPC trainer agents/tutors. Successful interns could get bonus to increase attractiveness of the programme.