REFLECTIONS ON THE INFORMATION TECHNOLOGY HONOURS PROGRAM USING A SYSTEMS APPROACH

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Abstract
In the South African context, most universities offer a three-year undergraduate degree followed by a further year of study to obtain an honours degree. Programmes in computing, such as information technology and other programmes with computer science majors (collectively IT), follow this same format. The high demand from students and constrained institutional resources for this further year of study necessitate the implementation of a student selection process, all the while being mindful of, among others, the expectations of students, the industry's demand for graduates, and the university's own academic requirements and financial constraints. There is also a rapidly changing IT environment that all role-players need to be cognizant of. This results in different perspectives on the honours programme and the handling thereof. This complexity, therefore, demands a critical reflection on the honours programme from different stakeholder perspectives to identify different problems and pressures. Therefore, the problem to be addressed in this research is effectively managing the IT honours programme and training lifecycle. Subsequently, the aim of this paper is to present a systematic reflection to diagnose the problems and posing questions with IT honours students' training lifecycle, based on the methodology of Churchman's systems approach: A problem can be referenced in terms of its objectives, sub-systems or elements, environment, resources, and management or coordination of all these. The three questions of Kant on reason are used to guide the process. Results anticipated from this study are the identification of the problems and arising questions within the IT Honours programme as well as the environment in which it functions. This is to be followed up with action research to do further reflective practice to improve the recognised problems. This will be done by examining the programme from several perspectives.

Keywords
Systems approach, Higher education, Honours programme, Computing, Multiple perspectives

1 | Introduction
The IT industry is continuously changing, improving and developing. It is often perceived as very complex. The continuing development of the education sector depends on keeping students abreast of such changes and incorporating such recently emerging areas of technology into the current curriculum (Aithal & Aithal, 2019). The requirements of the IT industry are a core focus when the curriculum is reviewed. As this process of re-curriculation is often taking long in higher education institutions, it is of importance to change or add to the discipline content in certain teaching and learning activities in order for students to stay abreast of the IT industry and to learn new technologies. This is a challenge when an academic programme is reviewed or renewed. In this paper we reflect on the management of the honours programme of a Computer Science and Information Systems department at a South African university.

In the South African higher education landscape, a three-year undergraduate degree can give a student access to a further year of study to obtain an honours degree, after which they can continue with studies at the master's and

doctoral levels. Our department offers a choice of two undergraduate degree programmes, i.e., a BSc in Information Technology, and a double major BSc, with Computer Science as one major and another natural science subject as the second major. Both programmes can then allow students to continue with the honours degree: BSc Hons in Computer Science and Information Systems. This further year of study allows for specialisation in specific sub-fields over and above the general nature of the preceding undergraduate degree. This includes completing a capstone project that covers both research and practical implementation aspects relating to the chosen specialisation. This makes the graduates of this programme more sought after by potential employers. Therefore, there is a high demand from students to be admitted to the programme. However, the institutional resources that are required to facilitate teaching and learning at this specialised level are limited. This is the case for various types of resources, including human resources, financial implications, and physical lecture and computer lab spaces. These constraints mean that not all students can be admitted to the programme, necessitating the implementation of a selection process. However, it is necessary that the selection be done mindfully of the stakeholders that are directly or indirectly involved. This includes the students and their expectations, the industry's demand for graduates with specific graduate attributes that can accommodate the rapid change in the IT environment, and the university's own academic requirements for articulation.

The fact that students must undergo a selection process highlights the exclusivity of the programme and places a high responsibility of mindful management of the activities of the entire programme to ensure a high standard. This demands a formalised, critical evaluation of the honours programme from the viewpoint of the different stakeholders to identify existing problems and opportunities for improvement. We therefore conceptualised this evaluation as an ongoing multi-phase research project with the ultimate goal of being able to graduate students who embody the expectations of all stakeholders and to do this in the most effective manner. The first of these phases is the articulation of the current state of the honours programme training lifecycle and related activities which is presented in this paper. Subsequent activities will involve theorising on improving the status quo.

The work of Churchman (1968) introduced the concept of the systems approach as a formalised methodology to reflect on complex dynamics by conceptualising the interactions and agents in an environment (in this case the honours programme) as a system. By using the systems approach we can objectively analyse the honours programme, which will allow us to gain a holistic understanding of the nature of the situation. This analysis can then allow us to identify opportunities for change in the future phases of the project.

The remainder of the paper is structured as follows: Firstly, we will discuss the philosophical grounding for the project and the associated methodology. This includes a short discussion of Kant and Churchman. Secondly, the systems approach dictates 1) exploring and expressing the problem (in the *Problem statement* section); 2) identifying the stakeholders and analysing their perspectives (*Historical and current perspectives*); 3) a formal description of the system through Churchman modelling (*Churchman description of the system*). Next, a reflection is presented, by stating questions that arise from the modelling of the honours programme as a system. An indication of future work is also provided. The paper concludes with some final remarks.

2 | Philosophy and methodology

As was alluded to in the previous section, the ultimate purpose of this ongoing research project is to graduate students who embody the expectations of all stakeholders and to do this in the most effective manner. This requires that we think (reflect) about the current modus operandi in the honours programme, and then determine (reason) whether it is necessary to improve the programme and if needed how to improve the programme.

There is a distinct relationship between *reflection* and *reasoning* in that these cognitive processes can be used in the process of gaining understanding, problem-solving, and decision-making. Reflection refers to an introspective activity about one's personal experience and knowledge about a phenomenon. It produces a foundation for reasoning which is, in turn, a more factual and logical process of thinking which can lead to actionable outcomes.

The work of Churchman (1968) introduced the concept of the systems approach as a *reflective* methodology to understand problem situations by conceptualising the interactions and agents in the environment as a system. It provides an objective analysis of the situation, which allows practitioners to better understand the nature of the problem holistically.

Churchman (1968) identified five characteristics that should be considered when analysing a system through the systems approach: the system's overall objective, components, resources, environment, resources, and system management. Each of these characteristics contributes to understanding the system, its composition, and its boundaries. A short description of each characteristic is provided below.

The *overall objective* of the system is the outcome of the system, i.e., what is it that the system generates or that the system components, working together, deliver? However, care should be taken when expressing the system's objective. Often, the objectives of a system can differ depending on the perspective of the person expressing the objective. In a university context, an administrator of student matters can see student throughput to graduation as the

ultimate goal, while another tasked with research can consider student graduation as secondary to publication counts. These perspectives, however much it influences individual ideas of the objective, should not be the determining factor for expressing the goal. Rather, the actual overall objective of the system should be determined by a single outcome that multiple perspectives can agree upon not to compromise on, as no perspective will be willing to sacrifice their inherent idea of the most important outcome. Ideally, this objective should be able to be evaluated in terms of its success; quantitative outcomes can be measured, but qualitative outcomes can be more challenging to assess.

Any system comprises *components* that work together to achieve the system's objective. Each component has a specific purview and responsibility and coexists in specific relationships with one another that determines the nature of their interactions. The outcomes of each of these components contribute to the overall objective. The objective should, however, not be considered as a simple sum of the component outcomes. Some components do not necessarily contribute a direct outcome but can serve in facilitating or managing resources and environmental factors.

The enabling *resources* of a system are both the tangible and intangible assets that are available to the system and are under the system's control. The system harnesses these resources to achieve the overall objective by maximising the possible gain from the resources. Tangible assets include financials and physical assets, while intangibles can be related to human resources, interests, and related possibilities.

Systems never function in isolation. The *environment* in which the system is located imposes certain restrictions or affords possible augmentations to the system. This context of the system directly affects the elements that comprise the system. The boundary between the system and its environment is not always clear. In the academic context, the secondary schooling that students receive before enrolling can introduce a constraint on a university (as a system) if students are not adequately prepared for their tertiary studies. It influences the system, and the system has neither control over it nor scope to correct it. It is seen as a product of the environment. However, should the boundary judgement shift to include secondary schooling as part of the university system, interventions can be implemented to address the shortcomings as a natural part of tertiary education.

Finally, a system cannot function without being facilitated by some *management* aspect. The coordination of the activities (interaction between components), allocation of resources and navigation of constraints have to be governed in such a manner as to achieve synergy where the overall objective not only reflects the aggregated outcomes of the components of the system but transcends it through emergence.

The philosopher, Immanuel Kant (1781), was interested in the concept of *reasoning*. He proposed three guiding questions whereby the process of reasoning can be formulated:

- What can I know? This relates to gaining knowledge-based or factual insights into the phenomenon you are reasoning about. It can be based on observations, research, literature reviews, etc. (Van der Linde & Goede, 2021)
- What ought I to do? Determine which action should be taken to be able to improve the phenomenon that is being reasoned about.
- What may I hope? If the previously determined action is performed, and the action has the desired effect, what is the ideal outcome. Therefore, the end-goal of reasoning is to improve a situation or elevate the outcome.

Given the relationship between reflection and reasoning, we therefore propose using the questions of Kant (1781) that aim to aid in understanding phenomena, as a guide for the application of Churchman's systems approach (Churchman, 1968). The following mapping in Exhibit 1 shows the overlap between these two approaches.

Exhibit 1. Mapping of Kant's questions to Churchman's systems approach

Kant	Churchman
What can I know?	Components
What can I know?	Resources
What can I know?	Environment
What can I do?	Management
What can I hope?	Overall objective

Churchman's systems approach can be used to understand complex phenomena by conceptualising them as systems through **reflection** of the characteristics of the system. Furthermore, Ison (2017), in his paper on situations of uncertainty, compares a practitioner/researcher/lecturer to a juggler. Therefore, it is expected of this "juggler" to manage many tasks/actions simultaneously. Firstly, it is required to be aware of what you are doing and why it is necessary. Secondly, it is important to engage with the real-world and thus be aware of all the stakeholders in the situation. As a third ball Ison refers to the context and the way one adapts to the circumstances. Finally, the fourth ball

is managing all of these activities. This also relates to the overall management of Churchman and the "what can I do" question of Kant as seen in Exhibit 1.

In the next section the application of the approach is presented, by discussing the problem situation and historical and current perspective of the honours programme. Therefore, the focus is on answering question 1 of Kant (What can I know?).

3 | Application of the systems approach

In this section we are first going to give a background of the problem that we are addressing in this paper. This will be followed by a discussion of the historical and current perspectives of the honours programme and management of this. Finally, the situation will be described using Churchman's five characteristics.

3.1 | Problem statement

The first aspect that we are addressing in this paper is the question of what is the "best" way of selecting students to take part in our Honours program. In the past this was not a problem as the number of applicants was low enough to accept all students that met the minimum academic requirements. However, over time the number of applications has increased to a point where the number of eligible applicants has exceeded the capacity. Furthermore, there has been a growing number of applications from a diverse range of institutions with backgrounds that do not always fit in our program.

The second aspect that we are addressing is the success of our reception program – both in preparing the students for the honours programme year as well as developing their graduate attributes.

These two aspects are approached from different viewpoints. The first viewpoint is the expectations that industry has regarding the skillset and work-readiness of a student that has graduated with an Honours degree. The second viewpoint is the expectations of the student. Finally, the expectations of the university regarding graduate attributes and academic articulation also needs to be addressed (NWU, 2021).

3.2 | Historical and current perspectives

The Department of Computer Science at North-West University was founded in the mid-1970s. A few decades later the Department was incorporated as the Subject group Computer Science and Information System into the School of Computer, Statistical and Mathematical Sciences and in 2017 it became a School on its own, now known as the School of Computer Science and Information Systems. Initially Computer Science was offered as a major for the BSc degree with a second major coming from subjects such as Physics, Mathematics, Statistics, Chemistry and so on. Information Systems was offered as a major for the BCom degree with a second major from Economic and Management Sciences. The BSc in IT degree was developed as a CS and IT major with the first cohort of students graduating in the early 2000s.

In 1981 there were about 12 students in the third (final) year class. During the first few decades of its existence, the Department of Computer Science of North-West University could accommodate all student that wanted to do the Honours degree provided that they met the minimum criteria. The minimum criteria were that the applicant have a Bachelors degree with Computer Science or Information Systems as a major and that the degree was obtained with an average of at least 60% in the third (final) year.

In 2011 one of the authors (a staff member of the school) was tasked with managing the admission of Honours students. At that time most applications were from the School itself. Each applicant was invited for an interview, mainly to motivate the applicant. This process of interviewing would consume about two days of the staff member's time.

By 2014 the staff member was joined by another staff member (also one of the authors), and the number of applications started to exceed what the School could manage with its limited resources, both in terms of staff as well as physical space. Not only own students applied to the program, but a growing number of students from other institutions as well. At this stage therefore a selection process was implemented where students were selected not only on their undergraduate grades but on their ranking as well. Furthermore, students from other institutions who did not have the same academic background as the North-West University's students, and therefore did not have the necessary prerequisite knowledge to be able to do the honours courses were advised to first do a number of undergraduate courses and then re-apply for the honours programme.

This selection process was followed quite successfully until the global COVID pandemic brought about a reinvention of the higher education system. As a result, not only was teaching and learning moved to an online mode, but also assessment moved online. Now students that did not do very well with sit-down assessments started to excel

and obtain high grades. Incidentally, there is also an as yet unconfirmed feeling that students that excelled in a face -to-face teaching and learning situation with sit-down assessments started to be left behind.

The nagging doubt in the trustworthiness of grades obtained during the COVID era therefore led to a rethinking of our selection process. The selection process is now based on a combination of undergraduate grades for modules on both second- and third-year levels as well as an entrance exam. The entrance exam is a sit-down exam and takes place during the second semester halfway between the mid-semester assessments and final exam. The exam consists of a compulsory programming section as well as a written section. For the written section candidates have to do three questions from seven that cover the core modules on second- and third-year level.

The decision was made to not do any pre-selection but rather to invite all applicants to write the entrance exam. In the first year that this was done (2021), there were 170 applications of which 70 wrote the entrance exam. In 2022 the same trend was observed. A question that needs to be answered here is whether students do a bit of self-selection when faced with the reality of having to do a sit-down exam.

Another activity that was introduced by one of the authors is a reception programme that takes place during the two weeks before the official start of the academic year. The reception programme consists of a number of components.

The main component is a teambuilding exercise where the students are randomly place in teams and given a robot assignment that they need to solve using Lego Mindstorm robots. There are typically one or two assignments per day and the students are rotated into new teams for each assessment. Team leaders are selected beforehand and continue in this role right through the duration of the reception programme. At the end of each assignment the team leaders are asked to nominate the best participating team member for that assignment. At the end of the programme all the team members are asked to select the best team leaders. One of two of the assignment that the students have to solve will be based on technology such as Raspberry Pi and sensors.

Another component of the programme is the introduction of the honours modules to the students by the lecturers and the given an opportunity to ask questions about the modules. By doing this, they can make informed decisions when selecting their modules for the year. Furthermore, the available projects are also presented to the students and once again they have the opportunity they can get clarity on the topics by consulting with the different project supervisors. Other administrative arrangements are also shared with them such as workspace and timetables.

Finally, there is also a social event where the students and staff can mingle informally before the lectures start.

When reflecting on the selection process and reception programme over the past few years, we need to ascertain what is the best way for all stakeholders involved.

By reflecting on the honours programme and its history, it becomes obvious that more inquiry is needed by involving stakeholders such as students, supervisors/lecturers and industry partners to obtain their feedback.

3.3 | Description of the system according to Churchman

This section is employed to describe the current system of the honours program when conceptualised as a system. The discussion here is twofold: to describe the current system using Churchman's characteristics and to reflect on the system's boundaries.

Given this discussion of the Churchman characteristics, a description of the honours programme conceptualised as a system is presented in 2, where the first column shows the characteristics, and the second column describes the characteristic in the current system. Finally, a reflection on the rationale for the description is presented in the last column.

Exhibit 2. Churchman characteristics

Churchman characteristic	Description	Reflection on rationale
Components	- Administrative sub-system - Academic sub-system - Supplementary sub-system - Resources sub-system - Management sub-system	The components of the system comprise several sub-systems that are interrelated and work together towards the overall objective. Their relationship and interaction are shown in Exhibit 3. Each sub-system is briefly contextualised: The administrative sub-system concerns system activities relating to selection processes (assessing prospective student applications and admissions tests) and project assignment processes (matching research supervisors and students based on research themes, preferences, and previous academic performance). These activities are ideally performed by admin staff, sometimes under academic supervision). The activities of the academic sub-system relate to the typical day-to-day work of the academics involved in the programme, i.e., convening, teaching, and assessment in the honours courses and supervising honours research projects. Supplementary to the regular academic activities in the programme, there are other activities that are performed in addition thereto which are not strictly related to a student's courses or research or an academic's regular work. These activities typically support the academic sub-system but are also beneficial to the personal development of a student. These activities include a pre-academic reception programme hosted by the academics to welcome new honours students and promote a sense of belonging and ownership. It also serves as a vehicle for advising on structuring each student's curriculum from the pool of elective courses. Furthermore, honours students engage in the tutorship of undergraduate courses and community engagement to foster a culture of giving back for having received in the past. Even though management and resources are characteristics of the system, they are also considered sub-systems in the honours programme that uniquely interact with other components. They are each described in their relevant rows below.
- Resources	- Staff expertise and interests (willingness) - Budget (spending of)	In the context of the honours programme, there are very few resources that are available to the system. The resources are conceptualised as being of two types: human resource-based and finance-based. The academic staff complement conveys a wealth of expertise in diverse academic (sub)disciplines. This is a resource that should be harnessed in an effective manner to pair courses and research supervision accordingly so that academics are utilised in contexts that fit their expertise and can maximally contribute to the programme. Budget allocation to the academic department which houses the programme is considered a resource that the system has at its disposal. Prioritising spending on supporting the sub-system activities can provide support in various aspects. The system has control over how the budget is spent but not the actual size of the budget, which in turn can be considered an environmental constraint of the system, as discussed below.

Churchman characteristic	Description	Reflection on rationale
Environment	- Limited facilities and equipment - Supervision capacity - Stakeholders' expectations - Budget (size of)	The environment that constrains the system can be described in terms of two factors, namely material and intangible (human-related). The first material aspect includes limitations of facilities in terms of availability, suitability, and size. Related to facilities is the aspect of equipment, e.g., honours computer labs and workspaces, robotics equipment (reception programme and community engagement – supplementary sub-system). Finances (budget) are the second material aspect. As noted above, the spending of the allocated budget is considered a resource of the system. However, the size of the allocation falls outside of the boundary of the system. This is determined by senior management at the faculty and institutional level. The system has no influence and, therefore, the size of the allocated budget is considered an environmental constraint. Attracting and retaining staff has long since been a challenge for many CS/IS/IT academic departments (Cohoon, Shwalb, & Chen, 2003). Higher staff turnover often means that temporary measures are put in place to cover teaching responsibilities associated with vacancies, but the supervision of honours students is only performed by the core academic staff complement and vacancies reduce this number. Furthermore, these academics do not only supervise honours students but also students at master's and doctoral levels. The limited supervision capacity is, therefore, an environmental constraint on the system. The expectations of the stakeholders involved in the honours programme adapt and change over time. Expectations can be based on a combination of objective and subjective aspects related to the honours curriculum (e.g., technological proficiencies) and the more intangible aspects such as personal growth and development.
Management	- To achieve synergy - How can all of the above be managed and integrated in a multi-perspective and reflective way?	The management of the honours programme needs to be addressed to improve the quality of the students that graduate, thereby satisfying the needs of all stakeholders. This is part of the second question of Kant "What ought I to do?" and will be addressed in future work
Overall objective	- Graduating students who embody the expectations of all stakeholders (industry/student/academia).	The ultimate goal of the honours programme is to produce fully rounded honours graduates that meet the expectations of academia and industry while also meeting the honours students' own expectations: Industry (referring to IT companies in general) expects graduates who are technically proficient, emotionally mature, and socially capable. Academia expects graduates who are adequately prepared for articulation to further levels of study, i.e., being able to progress to master's level study. Students (as a graduate at the end of the programme) have expectations that are aligned with both industry and academia but with an added nuance of the personal fulfilment/growth that participation in the programme can bring.

Boundary critique is used to differentiate between that which belongs either to the resources or to the environment of a system (Ulrich 1983). Some empirical observations can be viewed as more essential than others (Ulrich 2005). The definition of boundary critique is "*a systematic – reflective – and discursive – effort of handling boundary judgements critically, whereby 'critically' means both self-critical questioning one's own claims and 'thinking for oneself' before adopting the claims of others*" (Ulrich and Reynolds 2010). Therefore, it is a critical process to identify the boundaries and the ethical assumptions of the system. All stakeholders' needs and views has to be taken in to account when reflecting on a system. For the honours programme that is discussed in this paper the affected are the students and the boundaries are shown including the components and interactions in Exhibit 3.

Exhibit 3. Graphical depiction of the system
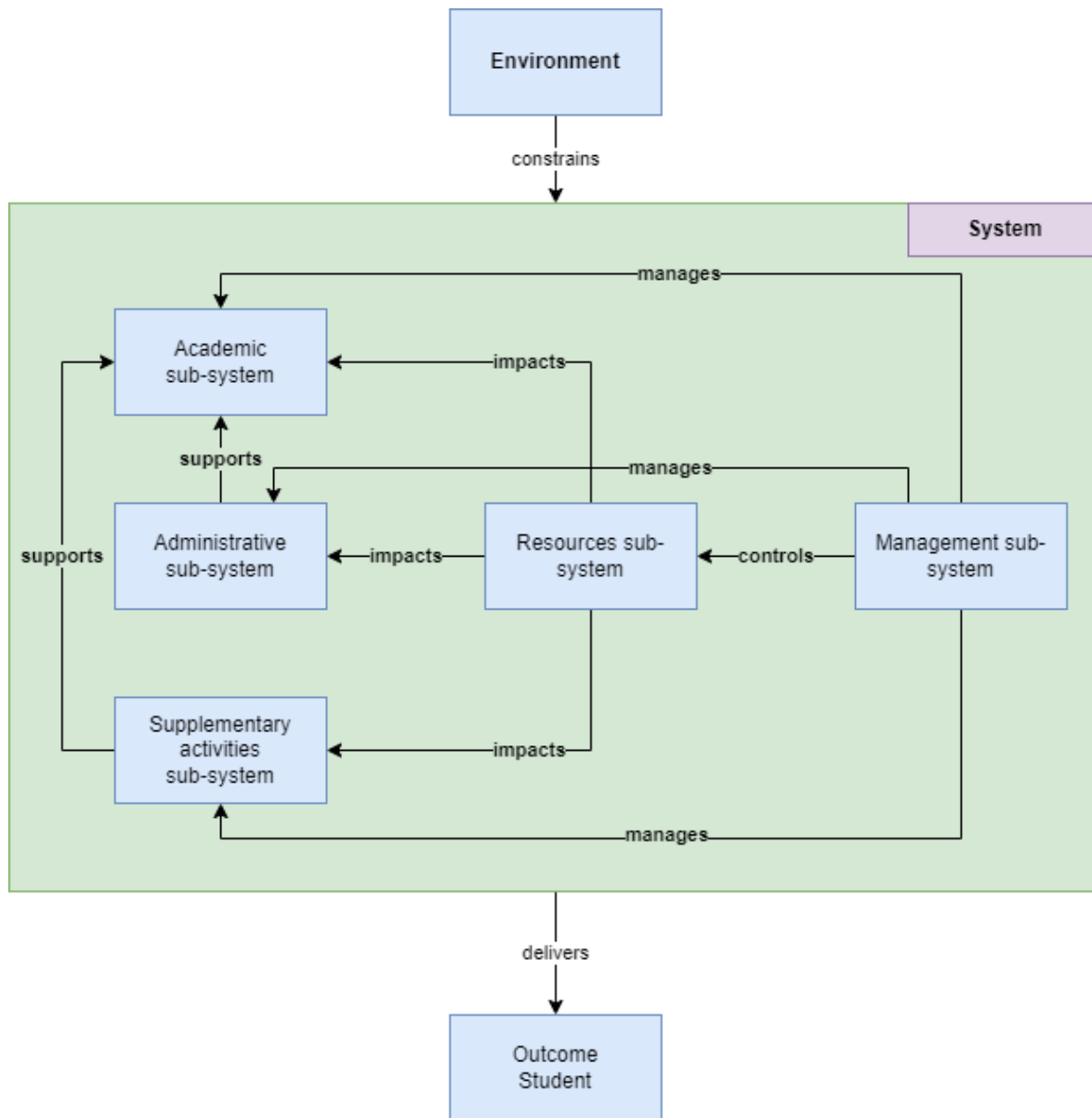
It is seen that the situation is impacted by the environment, and the sub-systems are impacting each other. Ultimately the aim is to deliver a well-rounded student ("What can I hope?").
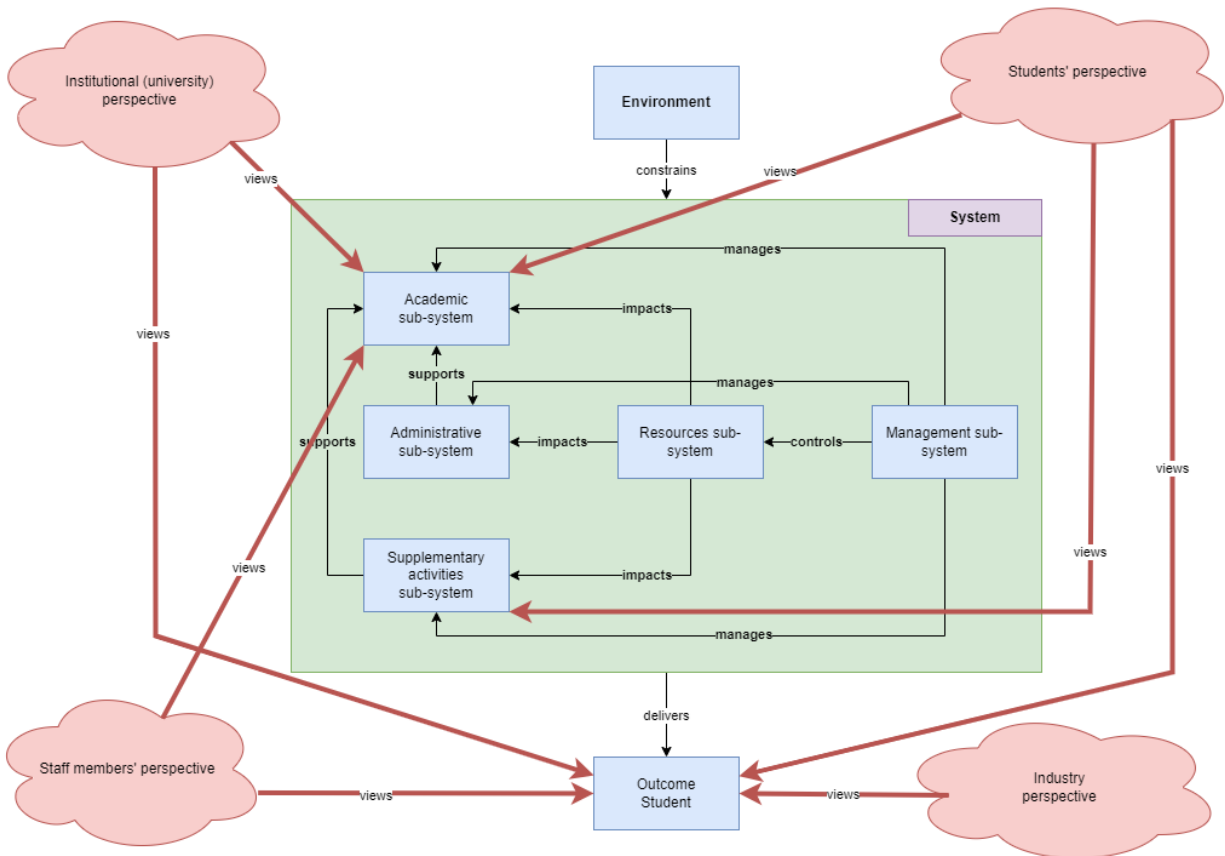
4 | Reflection and future work

The systems idea, from a Kantian perspective, is the "problematic but unavoidable notion of totality of relevant conditions – a totality we cannot possibly know, although we can and must nevertheless think it" (Ulrich 1983). This implies that individuals view a phenomenon in terms of their perspectives (conditioned realities) and that understanding is enhanced by knowing more conditioned realities. However, one can never achieve understanding of all possible conditioned realities. Ulrich's Critical Systems Heuristics provides a methodology for understanding and articulating different conditioned realities.

In exhibit 4 an initial view of the stakeholders that have an involvement in the honours programme, and their perspectives are indicated. These include among others:

- The university is mainly interested in the quality of the academic subsystem, as well as the quality and number of graduates.
- The student wants to get a qualification that will enable him/her to get a good work position.
- The industry needs graduates that are work ready and able to solve problems.
- The staff member wants to work with students that are capable to grow and be successful in the programme.

Exhibit 4. Stakeholder perspectives on the system

The perspectives above and conditioned realties of stakeholders will be addressed in future work.

The reflection done on our honours programme, the selection process and the reception programme, bring forth the fowling questions:

- Do we get the best students to come and write the selection process?
- Is the entrance exam the best way to assess the readiness of students to enter the honours programme?
- Is the entrance exam a fair and ethical way of selecting students for the programme?
- How well will selected students do in the year ahead?
- To what extend does the reception programme prepare the students for the academic year ahead with all the challenges that they may face?
- Is there an improvement in the soft skills of these students?
- Etc.

By reflecting on the honours programme, its history and possible questions arising, a deeper inquiry is needed by involving the stakeholders as listed in Exhibit 4.

5 | Closing remarks

We have seen that due to the high demand from students for this additional year of study (honours) and the limited resources of the universities, a rigorous but fair student screening procedure has to be put in place. Striking a careful balance between a variety of criteria is necessary for this effort, including student goals, the demand for skilled graduates in industry, academic standards and financial and other constraints of the institution. The IT sector is undergoing fast changes, which highlights the necessity for collective attention among all stakeholders to produce work-ready employable graduates.

This reflection and reasoning on the honours programme is a starting point for improving the honours programme, by answering the "What can I know?" question of Kant. This is indicated in the Churchman's categories of components/subsystems, resources and environment.

Now that we know what we know, we need to ask the question: "What ought I to do?"- that will address Churchman's category of the management of the honours programme.

The ultimate goal is to realise the question of "What can I hope?" of Kant – referring to Churchman's category of the overall objective. That is the improvement of the honours programme to deliver the "best" graduates possible. In order to get to the improvement, the reflection and inquiry is ongoing, using multiple perspectives of the affected and involved, trying to understand the complexities of this academic situation.

Through the fusion of systems thinking and reflective engagement, this endeavor seeks not only to illuminate the current challenges, and questions, but also to cut a trajectory towards their correction and enhancement.

6 | References

Aithal, P. S., & Aithal, S. (2019). Innovation in B. Tech. Curriculum as B. Tech. (Hons) by integrating STEAM, ESEP & IPR features. *International Journal of Case Studies in Business, IT, and Education (IJCSBE),* 3(1), 56-71. https://dx.doi.org/10.2139/ssrn.3406824

Churchman, C. W. (1968). *The systems approach*. New York: Delacorte Press.

Cohoon, J. M., Shwalb, R., & Chen, L.-Y. (2003). Faculty turnover in CS departments. *ACM SIGCSE Bulletin, 35*(1), 108-112. https://dl.acm.org/doi/10.1145/611892.611944#:~:text=https%3A//doi.org/10.1145/611892.611944

Ison, R. (2017). *Systems practice: How to act: In situations of uncertainty and complexity in a climate-change world.* London: Springer, https://link.springer.com/book/10.1007/978-1-4471-7351-9

Kant, I. (1781). *Critique of pure reason* (P. Guyer & A. W. Wood Eds.): Cambridge: University Press.

NWU. (2021). *North-West University teaching and learning strategy (2021-2025).* https://www.nwu.ac.za/sites/www.nwu.ac.za/files/files/i-governance-management/documents/T%26L-Strategy-2021-2025.pdf

Ulrich, W. (1983). *Critical heuristics of social planning: A new approach to practical philosophy*. John Wiley and Sons, Chichester. https://www.wiley.com/en-us/Critical+Heuristics+of+Social+Planning%3A+A+New+Approach+to+Practical+Philosophy-p-9780471953456

Ulrich, W. (2005). *A brief introduction to critical systems heuristics* (CSH). ECOSENSUS. https://i2s.anu.edu.au/wp-content/uploads/2014/02/ulrich_2005f.pdf

Ulrich, W., & Reynolds, M. (2010). Critical systems heuristics. In: *Systems approaches to managing change: a practical guide*. Springer, 243-292

Van der Linde, S., & Goede, R. (2021). From Kant's Critique of Pure Reason, to Action Research in Improving the Programming Skills of Students. *Systemic Practice and Action Research*, *34*(4), 419-440. https://link.springer.com/article/10.1007/s11213-020-09543-8