To: Joseph Shepherd, Vice President of Student Affairs

From: Advisory Committee on Residential Life

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Subject: Recommendations on how to revamp the rotation process

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INTRODUCTION

This report provides consensus recommendations on how to revamp the rotation process, starting with the incoming new students in Fall 2018.

In preparing this report, the committee sought input from the IHC as well as other members of the student body and students affairs staff. Rotation data from previous years was also used to simulate various scenarios and come up with the first iteration of the proposed process.

The remainder of the report is structured as follows. First, we describe a set of guiding principles that underlie our recommendations and that we believe can be used to evaluate future improvements to the rotation process. Second, we describe a set of recommendations for a revamped rotation system. Third, we conclude with a discussion of questions that we are eager to give further consideration once we get new data this Fall.

GUIDING PRINCIPLES

To guide our work in revamping the rotation system, the committee discussed a number of principles that captured key elements of the COUCH report, as well as some of the themes reflected in our previous recommendations. The following principles are intended to serve as a underlying rationale for the choices that were made in coming up with our recommendations, and reflect the priorities of the group in terms of how the rotation process should be implemented going forward.

Identify processes that maximize the residential experience for Caltech undergraduates, and promote academic and personal success. The residential life system should enable the academic success of students and provide opportunities for intellectual engagement (with faculty, students, staff, and others). Caltech is foremost a learning community, and this includes learning both inside and outside of the classroom. An ideal residential life system is one that supports diversity of thought, provides a safe space for conversation, and includes resources for furthering academic and personal excellence. In addition, our houses and residences should provide a supportive culture that discourages negative views of individual students, groups, or communities. An important component of this principle is accommodating students with special needs.

Rely on iterative and evidence-based approaches. We view the work of improving our residential system as an ongoing process of trying things out, seeing what works, and using data to guide future updates to the system. Thus, the recommendations outlined here should be re-evaluated annually, and we expect that we will learn ways to improve upon them based on experience. In addition, houses, residences, and students should be incentivized to seek continuous improvement in the residential life system and to amplify the positive features of different residential environments.

Facilitate informed student choice. Students should be given the opportunity to choose their residential environment, subject to constraints on space available, with access to full information about the available processes and underlying choices. Rotation is an important part of this process since it gives incoming students the opportunity to learn about the unique opportunities afforded by our residential system. For this reason, it is important that the rotation process provide incoming students with opportunities to accurately learn about the different options so they can make informed choices.

Enable an ecosystem of diverse residential experiences. Historically, a unique aspect of the Caltech residential experience has been the existence of a number of houses with distinct cultures, which provides incoming students with the opportunity to become members of houses that match their interests and personalities. In making these recommendations, the committee has sought to preserve this aspect of our housing system while addressing some issues with the previous system and accommodating the introduction of Bechtel as a new residential option. The committee also believes that our residential system should provide students with the ability to experience different residential environments over time, and that Bechtel provides a unique opportunity to experiment with new ideas in this regard.

Implement transparent student-governed processes. The processes used to determine residential assignments and resolve issues should be widely known in order to help individuals make good decisions and meet the Institute's and students' high expectations for transparency and fairness, as well as Caltech's Code of Conduct and the Honor Code.

By building on the foundation provided by the COUCH report, the committee believes that these principles, and the recommendations that follow from them, are consistent with the principles established by the undergraduates in their report on the “Polaris Plan” (Winter 2017), the guidance provided to the committee in Vice President Shepherd’s memo of February 1, 2018 laying out the plans for the opening of the Bechtel Residence, as well as Vice President Shepherd’s charge to the Advisory Committee on Residential Life (ACRL) when it was established.

RECOMMENDATIONS

Recommendation 1. Improve the process to identify and address cases of concern during the rotation process.

Background:

- Every year we struggle to find good assignments for a small number of incoming students for whom the rotation process might not be the best way to find a house assignment, which we refer to as "cases of concern”.
- Finding good residential assignments for cases of concern is critical for the overall well-being of these students during their time at Caltech, as well as for the community at large.
- In the past, the IHC has spent considerable and commendable effort trying to address this challenge. However, given the difficulty and stakes involved, we recommend a more systematic approach that incorporates best practices and brings into the process individuals with professional expertise.

Detailed recommendations:

- A committee should be created to identify cases of concern during the rotation process and to make residential assignments for these cases with the goal of maximizing the quality of the residential experience for these students, as well as the community as a whole. The committee should include an Associate Dean, a member of the Counseling Center staff, and the IHC Chair.
- The committee will have the following responsibilities: 1) consult daily during the rotation process to identify and discuss potential cases of concern, 2) determine the final list of cases of concern for whom residential assignments should not be determined by the algorithm described below, and 3) make a recommendation about the residential assignment for these cases of concern.
- An important component of this process is gathering information from the community as the process unfolds.To facilitate this process, incoming and continuing students should be encouraged to reach out to RAs, members of the IHC, or the deans with any potential concerns, who should then route the appropriate information to the committee.

- The committee should make recommendations to the Dean of Undergraduate Students, who will have the responsibility of making the final decision.
- Given the importance of finding good outcomes for these cases, we also recommend that the residential assignment for cases of concern be determined at the outset, before the algorithm described below is implemented.
- The existence of this procedure should be known, but information about which cases fall in this category should remain private. In particular, individuals outside the committee or the Dean's office should not know if their residential allocation was determined through this procedure or through the regular assignment algorithm.

Recommendation 2. Adopt a revamped residential assignment algorithm.

Background:

- For the last several years the IHC has used an algorithmic approach to determine the primary house assignments, with inputs consisting of the preferences of the students toward the houses and of the houses toward the students. A recent innovation has been to use ideas from social science, such as the concept of stable matching, to carry out a portion of the process using an algorithm to analyze the ranking data. The advantage of this algorithmic approach is that it can decrease the time spent on the matching process and allow more complex criteria to be used to achieve diversity and balance in residential assignments.
- There has been substantial concern -- expressed by staff, faculty, and students to differing degrees -- that some portions of the past rotation process have had undesirable characteristics, such as social pressure to participate in rotation and asking existing students to judge first year students based on relatively limited social interactions.
- There has also been concern expressed by current students and alumni that changes to the rotation process might destroy the many positive aspects of Caltech's unique residential system, including the camaraderie that students feel toward their housemates and the support structure that the houses provide to the students.

Overview:

- The proposed residential algorithm has three main components: 1) input from incoming students, in the form of a ranking of all the residential options, 2) input information from each of the eight houses in the form of a "best-fit list" of potential new members, and 3) an assignment algorithm that uses the input information from houses and incoming students to determine a residential assignment.
- The assignment algorithm consists of three stages, which are described below in more detail.

Detailed recommendations on incoming student input:

- At the end of rotation, incoming students will have to complete a form indicating their residential preferences.

- The form has two mandatory components:
  1. Students will be required to provide a complete ordinal ranking of all the houses and Bechtel.
  2. Students will also be asked to indicate if they want to receive a house affiliation in the event that their first year residence is Bechtel, or if instead they prefer to remain unaffiliated.
- The rankings should allow for indifferences with one exception: students can only select one option as their top preference.
- Submission of this form should be mandatory for ALL incoming students, even if they don't participate in any rotation events (see Recommendation 4 below). Any missing information, from failure to submit any preferences to failure to rank all houses, will be randomly added to the student's input.

Detailed recommendations on house input:

- Each of the eight houses is allowed to provide a best-fit list of potential new house members chosen from the new incoming class.
- The best-fit list is designed to allow houses identify incoming students who they believe will thrive in the house and be able to make significant contributions to the intellectual and social life of the house.
- We suggest that for Fall 2018 the maximum size of the best-fit list be set equal to 10 + 0.25 * M, where M is the number of freshman beds assigned to the house in the ACRL's second report.

Detailed recommendations on the assignment algorithm:

- The first stage of the algorithm involves identifying and making all "best-fit" matches between students' top choices and houses' best-fit lists.
- The first stage identifies and makes the following two types of matches:
  1. Incoming students who ranked a house first (i.e., a location other than Bechtel), and who are also in the best-fit list submitted by that house, are paired with that house.
  2. Students who ranked Bechtel first and also indicated a preference for <u>not</u> receiving a house affiliation are paired with Bechtel.
- Although we don't expect this issue to arise, there is a possibility that the number of incoming students who rank Bechtel first and want to remain unaffiliated with a house exceeds the number of beds available in Bechtel. If this happens, the Bechtel slots will be allocated randomly at this stage.
- The next two stages of the algorithm are used to determine the assignments of students who remain unpaired after the first stage.
- The second stage of the algorithm involves identifying optimal assignments for all remaining students based on the following convex-penalty optimization problem:

$$\min_{\alpha} \sum_i [o_i(\alpha(i))]^2 \quad \text{subject to} \quad \sum_i I(\alpha(i) = j) \leq B_j \text{ for all } j$$

where:

B_j = # beds available in house/residence *j*
(after assignments made for cases of concern and stage 1)

$o_i(j)$ = ordinal ranking that student *i* gives to house/residence *j*
(1 = most preferred, 2 = second most preferred, …)

α = functions describing assignment of students to houses
with $\alpha(i)$ denoting house/residence assigned to student *i*

- Some of the key properties of this stage are worth highlighting. First, it is designed to identify good assignments based only on incoming students' ordinal preferences. Second, it seeks to assign students to the locations that they prefer by defining a penalty that increases with the square of the students' preferences. Thus, if a student is assigned to her top option, the penalty associated with her assignment is 1, but if she is assigned to her fifth option, the penalty is 25.
- This optimization problem is likely to generate multiple solutions, which means that there are many possible assignments that look equally attractive from the perspective of the incoming students' aggregate preferences. The third stage of the algorithm is designed to address this.
- The third stage of the algorithm involves selecting a final assignment out of the optimal set generated in stage 2, using the following optimization problem:

$$\max_{\alpha \in A^*} \min\{\delta_{Avery}(\alpha), \ldots, \delta_{Ruddock}(\alpha),\}$$

where:

A^*= Set of optimal assignments identified in stage 2

$\delta_j(\alpha)$ = number of students in the dream list for house *j* that end-up in house *j* if assignment α is implemented, including those made in stage 1 and through the cases of concern process

- This third stage is based only on the houses' best-fit lists and is designed to find the assignment that gives all of the houses a chance to match with as many students in their best-fit list as possible, and thus helps them advance the intellectual and social life of the house.
- There is a possibility that the optimization problem at this stage will still lead to multiple solutions. In this case, the IHC will be tasked with selecting a solution. We urge the IHC to use other data in choosing among the solution set, including gender balance or various forms of diversity.

Additional remarks:

- The algorithm does not guarantee that students will be assigned to one of their top n options. However, because of the square penalty function, assignments in which students are not allocated to highly ranked options are unlikely to occur. To investigate this, the IHC carried out simulations using data from last few year's rotation and found that 70-80% of students were allocated to their top option, 90-96% to their top two options, and 98-99% to their top three options.
- The assignments generated by the algorithm cannot violate other constraints of our current residential system such as the requirement that the the number of incoming students assigned to the North houses and Avery should have an equal number of men and women due to the constraint that all rooms are doubles. The algorithm described above should be implemented in a way that accommodates these additional constraints, as they evolve over time.

Recommendation 3. Process for assigning a house affiliation to incoming students assigned to Bechtel who indicate a desire to get one.

Background:

- In a previous report we recommended that the rotation process should allow for the possibility of some incoming students living in Bechtel during their first year while also receiving full house membership as part of the rotation outcome.
- This recommendation discusses how to implement this feature of the revamped rotation process.

Detailed recommendation:

- There are three categories of students generated by the main assignment algorithm described above: 1) those assigned a bed and full house affiliation to one of the eight houses, 2) those assigned to Bechtel and indicating a preference to remain unaffiliated, and 3) those assigned to Bechtel and indicating a preference to also receive full house affiliation. This recommendation applies only to this third group.
- The algorithm used to determine these additional house memberships is given by:

$$\min_{\beta} \sum_i [o_i(\beta(i))]^2 \quad \text{subject to } m_j(\alpha, \beta) \leq N_j \text{ for all } j$$

where:

α = function describing final bed assignments from main algorithm

β = function describing additional membership assignments made at this stage

$o_i(j)$ = ordinal ranking that student *i* gives to house *j* (1 = most preferred, 2 = second most preferred, ...)

$m_j(\alpha, \beta)$ = # students assigned membership to house *j*, given the assignment α generated by the main algorithm, and the additional house assignments β made at this stage

N_j = average number of incoming freshmen assigned to house *j* over the previous three years

- If this this optimization problem generates multiple solutions, one of them should be selected using an extension of stage-3 of the main algorithm to this case.

Recommendation 4. Allow incoming students to opt-out of rotation activities while encouraging students to take advantage of the opportunity to become well-informed regarding their residential options.

Background:

- There is an expectation that a handful of incoming students will prefer to opt-out of the rotation process and affiliated housing, and prefer to live in Bechtel.
- The ACRL was asked to think about how to accommodate this option within the revamped rotation system.

Detailed recommendation:

- We recommend that incoming students be allowed to opt-out of the rotation process and the affiliated house system.
- This includes making all rotation events opt-in so students can participate in any subset of rotation events of their choice, and allowing them to signal a preference to live in unaffiliated housing by ranking Bechtel and indicating a preference for remaining unaffiliated.

- However, we also recommend that incoming students receive orientation material explaining why rotation events are important and strongly recommended, even if they are NOT mandatory.

Recommendation 5. Facilitate the rotation experience for students who want to be affiliated with a house but struggle with the intense social nature of the rotation process.

Background:

- Every year there are incoming students who are curious about participating in the affiliated housing system and eventually benefit from it, but struggle with the high intensity and social nature of the rotation process, for example due to social anxiety.
- Although the IHC and house leadership already seeks to facilitate the process for these students, we believe that more could be done, and that these efforts could have significant returns for the students involved and the community at large

Detailed recommendation:

- We recommend establishing a more structured support system aimed at facilitating the rotation experience of this group of students.
- The support system should contain at least the following key components. First, incoming students should receive orientation materials about rotation that include a list of resources that students can contact if they struggle with rotation. This list of resources should include student leaders as well as contacts in the Dean's office and counseling center. Second, all contacts provided in the orientation material should receive training prior to rotation on best practices and procedures to be followed.
- In addition, we recommend that this process be supervised by the committee responsible for cases of concern (described in Recommendation 1). Although the issues involved here are substantially different, this committee could facilitate the deployment of help during the rotation process, and help identify any special circumstances that should be taken into account in determining the residential assignment of these students.

Recommendation 6. Emphasize procedural transparency during rotation process, and implement best-data practices to ensure privacy.

Background:

- The ACRL was also asked to think about how to introduce transparency into the revamped rotation process.

Details:

- We recommended the use of procedural transparency, which means that students should be fully informed about the rules and processes associated with the rotation and residential assignment processes, including the detailed algorithms behind them. This could be implemented in a number of ways, including the distribution of orientation

materials for incoming and (at least during the initial transition years) for continuing students.
- We also recommend extreme care in protecting the privacy of individuals. In particular, students should learn of their final residential assignment, but not the details of the process of how it was reached (e.g., whether it was determined as part of the process for cases of concern).
- In addition, to maximize privacy, we recommend that access to non-anonymous data be limited to those individuals responsible for implementing the actual assignment process (as described in the Recommendation 7).
- An important component of privacy is respecting incoming students desire to keep their house preferences to themselves. As a result, we highlight the importance of the existing rotation rules forbidding continuing students from asking incoming students to reveal their preferences.

Recommendation 7. The rotation process should continue to be largely run by the IHC, except for the changes required to accommodate other aspects of the rotation revamp.

Background:
- Historically, the rotation process has been run and implement largely by the IHC, in consultation with the Dean's and Housing Offices as required.
- The ACRL believes that student leadership is an invaluable part of the Caltech educational experience, and thus here we provide minimal changes to this aspect of the rotation system.

Detailed recommendations:
- The IHC will continue to be responsible for the implementation of the rotation process. This includes designing the schedule of rotation events, the design and distribution of orientation materials, the collection of input from houses and incoming students, the implementation of the assignment algorithms, and the communication of the rotation outcomes to incoming students.
- The chair of the IHC will also be part of the committee responsible for cases of concern, and thus facilitate this critical part of rotation.
- We recommend that the IHC invite the chair of the ACRL as an observer during the implementation of the assignment algorithms in order to assist with any issues that may arise, and to facilitate the ACRL's continued efforts to improve our residential life system, including the rotation process.
- We also recommend that the VPSA office assign some resources to the IHC to facilitate the safe collection and long-term storage of rotation related data. This issue has become especially relevant now with the introduction of new privacy laws by the European Union.
- We also recommend that the Housing Office, in collaboration with the IHC, develop a room pick process for the incoming students that will be living in Bechtel after rotation. We recommend a process in which the room pick order is determined by that students lottery, and in which a student is allowed to pull another person into a room pick in their

own suite in order to facilitate the formation of communities among the incoming freshman living in Bechtel.

Recommendation 8. Organize rotation events at Bechtel.

Background:

- The launch of Bechtel introduces some challenges for the rotation process: How should students become acquainted with this new option during rotation?

Detailed recommendations:

- We recommend that the Fall 2018 rotation include two dedicated time slots for lunches at Bechtel, each including half of the income class.
- These lunches should be organized and hosted by the Residential Life Coordinators, in collaboration and coordination with Bechtel's Faculty-in-Resident, the Housing office, and Student Affairs.

Additional remarks:

- We expect that the best way to structure events at Bechtel will change over time as the character of the residence begins to take shape.
- We favored the proposed recommendation for the short-term because early on Bechtel will lack the type of student leadership that implements rotation events at the houses.
- We proposed an initial experiment with lunches, instead of the more traditional rotation dinners, because in the early years Bechtel will be largely populated by students with other house affiliation, and many (or most) of them might choose to attend the rotation dinners at their own house. Upperclassmen in Bechtel should be encouraged to attend these lunches to provide a more accurate representation of the environment at Bechtel.

Recommendation 9. Extend the new rotation procedures to transfer students.

Background:

- Every year Caltech admits a small number of transfer students who also participate in rotation.
- Historically, transfer students have received a house affiliation during rotation, but they are <u>not</u> assigned a bed. However, they are eligible to take part in any house room picks immediately after rotation.

Detailed recommendations:

- We recommend that transfer students continue to participate in rotation in order to receive a house affiliation, but not a bed for their first year, and that they be eligible to take part on any housing room picks that take place immediately after rotation.
- This is easily accommodated into the system described here by asking transfer students to submit the same input information as incoming freshman at the end of rotation, and assigning a house affiliation using the procedure described in Recommendation 3.

- As a small technical issue, we recommend that transfer students be allowed to be included in houses' best-fit lists.

FINAL REMARKS

As we continue to emphasize, we view the recommendations presented here as an initial iteration on what will be an ongoing process of trying things out, seeing what works, and using data to guide future updates to the system. This trial-and-error approach is at the heart of the scientific (and engineering) method that is a hallmark of Caltech's academic culture and the committee believes it should also guide our approach to the residential life process. Thus, the recommendations presented here should be re-evaluated each year and modified as appropriate to improve upon them and better implement that guiding principles on which they are based. We encourage the campus community to take these recommendations as the first step that they are intended to be: give them a chance, see what works, and modify them accordingly going forward.

There are several specific items on which the committee had to use its best judgement and that would greatly benefit from additional data, which can and should be collected in the coming year:

- We expect to adjust the number of students on the houses' "best-fit lists," N, in future years, based on what we learn as the system is implemented. The current approach for determining this number was based on simulations using prior years' data that attempted to maximize the number of student that were placed in their highest preference houses while still allowing houses to express a preference for those student that they thought were a particularly good match to the culture and traditions of the house. Since those data necessarily excluded Bechtel as an option, re-assessing the appropriate value of N based on data collected in the fall will a priority for the committee.

- There was substantial discussion in the committee regarding how to achieve the right balance between a house's desire to indicate those student that they were most excited about welcoming to the house while at the same time allowing the preferences of the incoming students to be accounted for in the best possible way. A survey of how well the students in each house feel the process worked will help assess whether the recommended approaches achieved this balance.

- A key step in allowing students to experience a diversity of residential experiences over their time at Caltech is to allow students to spend time living in Bechtel without becoming "locked into" unaffiliated residential options. The extent to which students choose to live in Bechtel *and* have full membership in a house may illuminate whether the approaches to achieve this goal are effective. Data from future years, after first-year students and

upperclass students have had opportunities to move into and out of the houses and Bechtel, will also be useful.

- The committee also considered the following variation of the main assigmentment algorithm: 1) Collect two types of house input involving a smaller ‘best-fit list’ (smaller than currently proposed) and a larger ‘good-fit list’, 2) Use the ‘best-fit lists’ in the first stage of the algorithm, and 3) use the larger ‘good-fit lists’ to choose from the algorithm’s many prefrosh-optimizing solutions in stage 3 of the algorithm. We recommend that the ACRL gives further consideration to this variation of the algorithm next year after there is more relevant data from the coming rotation.