5.1.2 The Defect Zoo

- There are a lot of different defects, we have a veritable **zoo**. There is also an easy way of sorting "defects in crystals" into some meaningful categories.
  - We do that all the time with other things. For example, we like to differentiate the basic category "living beings" into animals, plants, fungi, and so on; after that we differentiate "animals" into, for example, birds, lions, fish, slime worms and bankers (however small the difference between the latter two might be).
- With defects the simple and time-honored sorting principle is:
- **1. "Zero"-dimensional defects** or "**point defects**".
  - These defects are very small in all *three* directions of space. As small as they can possibly be ("zero" dimension), and that means *atomic* dimensions.
    Our old friend the **vacancy** is a good example of a zero-dimensional defect, and so is an **interstitial carbon** atom in iron (we'll see in a moment what that means).
- **2. One-dimensional defects**.
  - This means that along some (virtual) *line* running through the crystal, something is wrong. Atoms sitting on (or close to) that line see an environment different from that of a perfect crystal.
  - There is only *one* basic kind of one-dimensional defect in existence, which we will call a "**dislocation**".
    Dislocations do tend to boggle the mind quite a bit as soon as we give them a closer look, sorry. However, they are of prime importance. Read the following sentence loud to yourself or whoever you can force to listen to you:

> **Adjusting the properties of your steel ultimately means that you deal with the dislocations in there.**

  - Now repeat it, just to make sure you got it.

> **Adjusting the properties of your steel ultimately means that you deal with the dislocations in there.**

  - So if we want to get answers to our still open "why" questions, we *must* deal with dislocations. They are at the very heart of the metal bending industry.
    Sorry. There is no shortcut. You must turn on your brain.
- **3. Two-dimensional defects**.
  - Something goes awry with your crystal on some (virtual) *plane*.
    We already know one defect of this type; we just haven't thought about it in these terms: it's simply the **surface**. Atoms there, if they look around, certainly do not see only proper neighbors in their proper positions.
  - Another two-dimensional defect easy to conceive is the good old **grain boundary** between two crystallites or grains in a poly crystal.
- **4. Three-dimensional defects**
  - They are easy to conceive. For example, just make a hole in your crystal by taking out many atoms. You don't know how to do this without messing up the crystal? It's easy. There are two ways of doing it:

    1. Make a lot of vacancies (you know how to do this: just make your crystal hot). Then see to it that they all cluster together, forming a vacancy agglomerate that is simply a little hole, better known as a "**void**".
    2. Take a magic knife or, better, brain knife that allows you to cut around in a crystal any way you like. Then scoop out a hole. Rest assured that whatever you can imagine doing to a crystal with you brain knife, mother nature can and will do in reality. You simply need not worry about *how* it is done.
- Working through that list is going to be our program for the next sub-chapter.
  - So gird you loins, fetch your favorite poison for relaxation, and beear with me.